8A Flight Readiness Review (FRR)

International Space Station Program
March 26, 2002

Agenda

Mission Overview	**Ben Sellari**
Vehicle Readiness **- On-Orbit Status** - **Ammonia Mated QD Hydraulic Lock-up** - **Open Paper Status**	**Steve Porter**
Avionics/Software Readiness	**Peggy Thomas**
Special Topic: • **Canadarm 2 Wrist Roll Joint Brake Fault**	**K. Lord, R. Castle, S. Razvi**
8A Flight Summary	**Ben Sellari**

8A Mission Overview

International Space Station Program
March 26, 2002

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- ISS 8A Consumables Status
- 8A Launch Commit Criteria

ISSP 8A Program Reviews

Launch Package Assessments (LPA), Feb. 15 2002 and Delta LPA Feb. 22 2002

- Addressed the launch package readiness for integration into the Orbiter.
- Successfully completed and authorized to complete payload processing
  - Requested delay in placing the S0 into the canister to 3/21/02 due to Ammonia Mated QD Hydraulic Lock-up issue.

Stage Operations Readiness Review, March 8, 2002

- Addressed CoFR 1& 2 requirements for cargo elements, middeck stowed hardware, launch package, personnel, facilities, and operations and their readiness to proceed to launch 8A on 4/4/02.
- Authorized to proceed to launch 8A with 5 exceptions and 3 action items to be readdressed at a Delta SORR to be held on March 20, 2002.

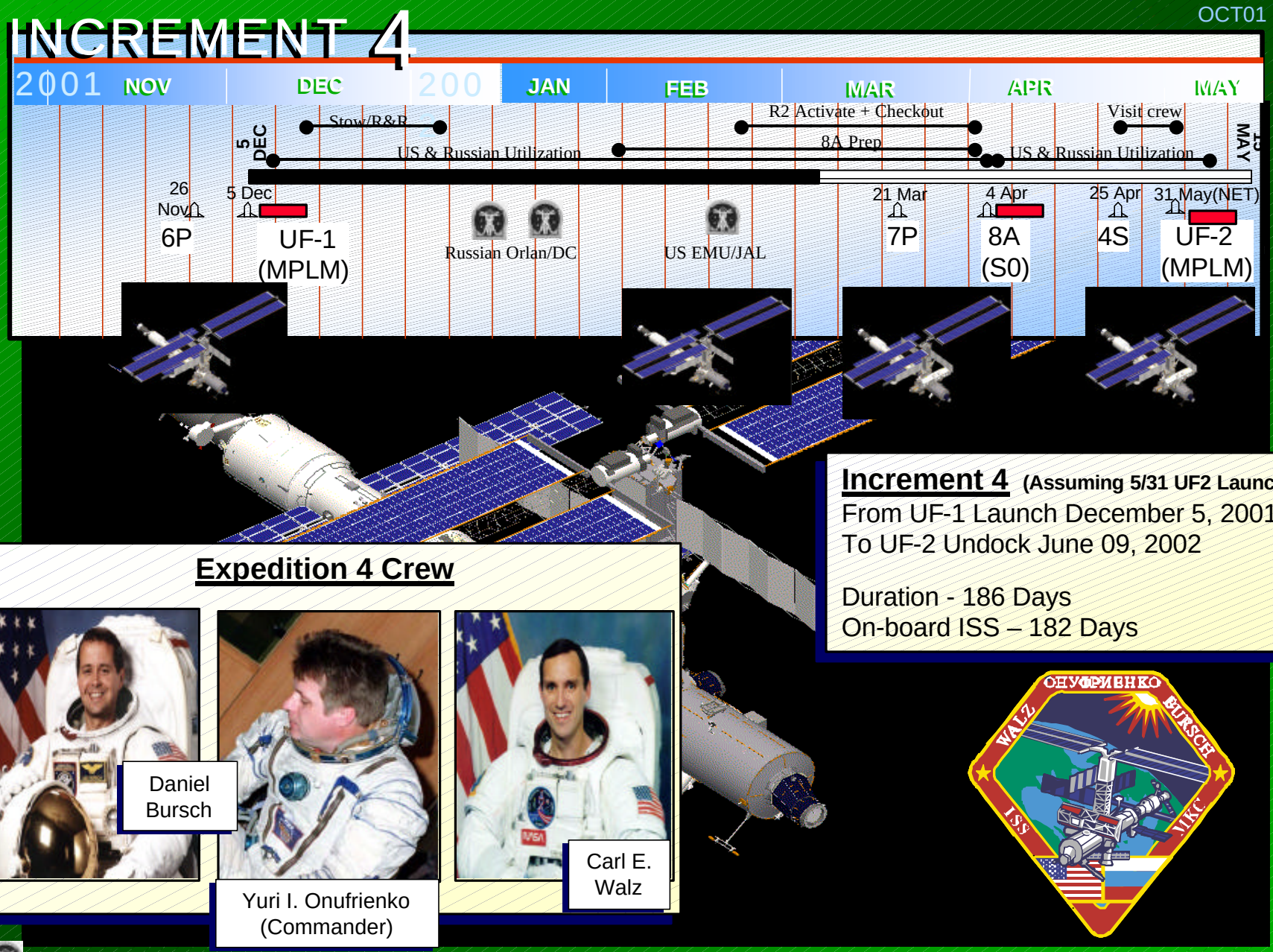
Delta Stage Operations Readiness Review, March 20, 2002

- Addressed the 5 exceptions and 3 actions Items identified at the SORR. Authorized to proceed to launch April 4, 2002 with one exception.

	ECD
METOX Safety Certification	Complete
LiOH/METOX Options for 8A	Complete
MT/CETA Fitcheck	Complete
NH3 Fluid Umbilical MLI	Complete
8A Berthing Loads	Complete
As-Designed/As-Built Reconciliation of 8A Hardware is not Complete	Complete
Ammonia QD Hydraulic Lockup	3/25/02
Canadarm2 Wrist Roll Joint Brake Bus Fault	4/02/02

INCREMENT 4

OCT01



Increment 4 **(Assuming 5/31 UF2 Launch)**
From UF-1 Launch December 5, 2001
To UF-2 Undock June 09, 2002

Duration - 186 Days
On-board ISS – 182 Days

Expedition 4 Crew

Daniel Bursch

Yuri I. Onufrienko (Commander)

Carl E. Walz

Denotes EVA

Increment 4 Accomplishments

● R2 Software Load Installation, Activation and Checkout			Complete
● Joint Airlock EVA and 8A EVA Preparatory Tasks			Complete
● Airlock and EMU Preparation and Checkout (Except for METOX regeneration)			Scheduled
● Airlock Battery Charger R&R, UIA Filter Changeout			Complete
● SSRMS SW Patch Installation, Activation and Test (6 & 7 DOF)			Scheduled
● ISS/Flt. 8A Crew Conferences			In Progress
● SSRMS Onboard Crew Training Sessions			In Progress
● ISS Crew Review of 8A Procedures and Timelines			In Progress
● Module to Truss Structures Attachment System (MTSAS) Checkout			Complete
● DDCU Umbilicals Configuration & S0 LTA Cable Checkout			Complete
● ISS 8A Pre-Pack			In Progress
● ISS LiOH Retrieval from Z1 Dome (for 8A)			Scheduled
● 7 Progress	Launch	03/21/02	Complete
	Docking	03/24/02	Scheduled
● Soyuz 4 Taxi Flight	Launch	04/25/02	Scheduled
	Docking	04/27/02	Scheduled
	Undock	05/05/02	Scheduled

Research Program Highlights

Achieving UF1 Stage Research Goals:

Completed significant utilization objectives:

- All runs of H-Reflex (3rd and final Increment run of the experiment)
- CBOSS (biotech cell science) operations for Increment 4
- Expedition 4 EarthKAM activities (involved over 17 schools and 2200 students)
- Education Operations for Increment 4
- Completed both planned Renal Stone sessions

On-going Utilization Objectives

- Continuing ADVASC, PuFF, Interactions, EVARM EVA in-suit radiation monitoring, and Crew Earth Observations.
- Significant number of ARIS ICE runs completed in preparation for microgravity-sensitive payloads in later Increments
- Significant number of operational hours for payloads requiring little crew interaction (e.g., PCG-STES, EXPPCS, SAMS, MAMS)

Increment 4: Stage 8A Overview

Stage Data

8A Undock Date:
April 13, 2002

Flight UF2 Dock Date:
NET June 02 or 03, 2002

Duration:
51 days

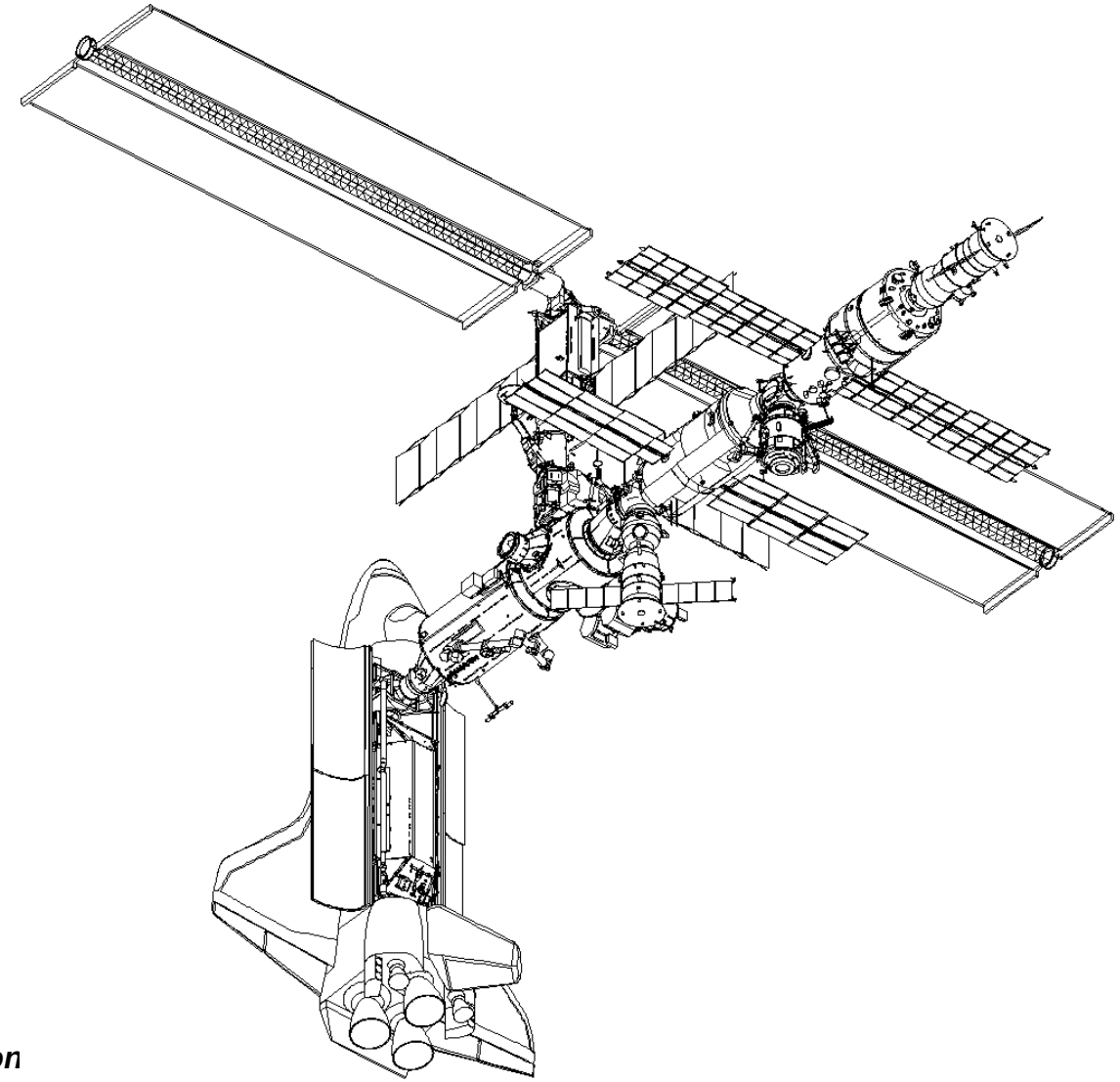
Increment 4 Crew

Commander	Flight Engineer	Flight Engineer
Yuri Onufrienko	Carl Walz	Dan Bursch

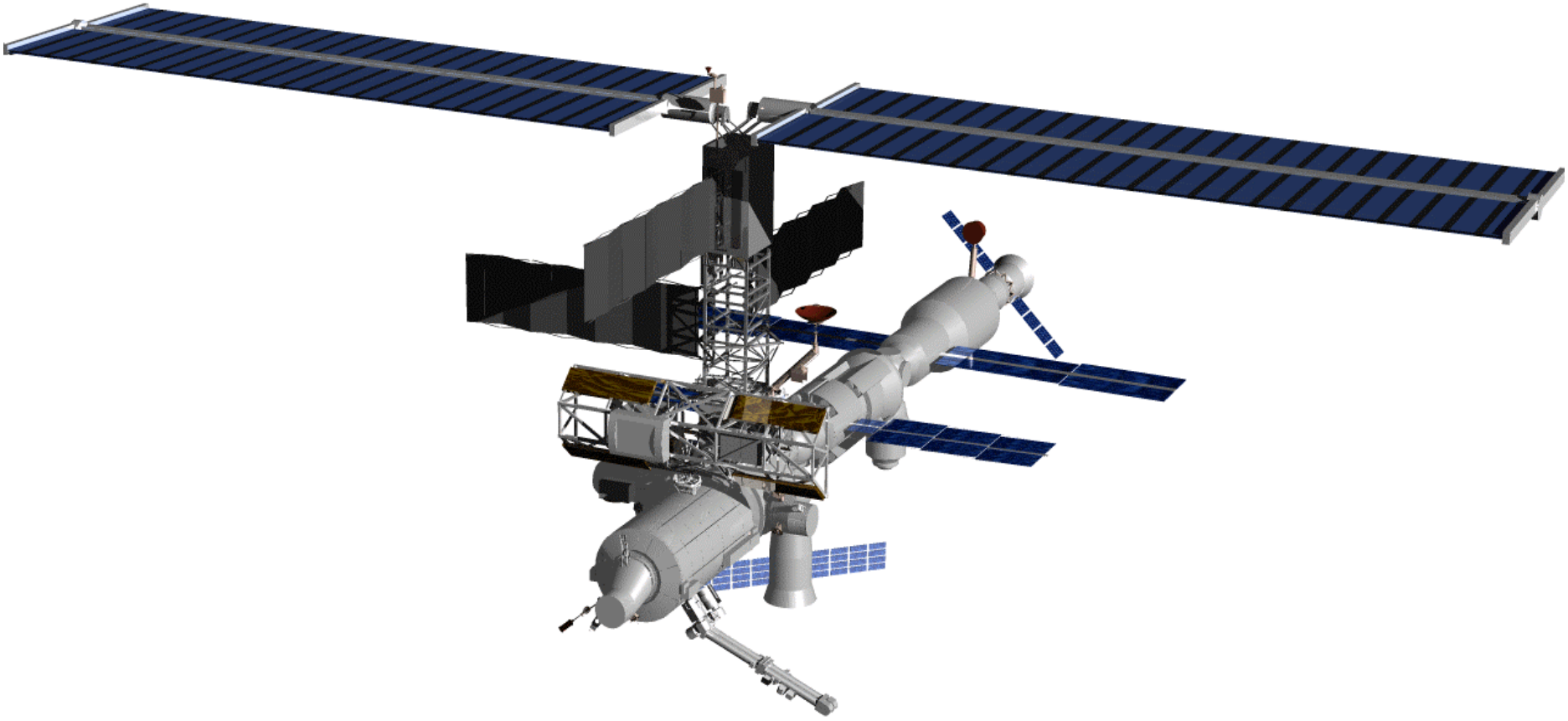
Stage Task

- ISS readiness for UF2
  - – ZSR removals (2) — Ready location for EXPRESS Rack deliveries on UF2
  - – SSRMS checkout — UF2 flight readiness test
  - – Soyuz Taxi crew — 1 Russian, 1 Italian, 1 Tourist (South Africa) for 8 days
  - – Soyus changeout — 4 Soyuz dock and 3 Soyuz undock
  - – UF2 Prepack — UF2 cargo transfers and operations
  - – Payload activities — Primary emphasis on science tasks, hardware checkouts lower priority
  - –Annex 2 Maint. — Essential tasks only: Required Preventative Maint, Corrective Maint to be determined on a case by case basis
  - –Annex 3 Imagery — Essential tasks only: Required inspections and closeouts
  - –Annex 4 Med Ops — Essential tasks only: less than 12 hrs/wk, definition in progress
  - –US and Russian Utilization: — Schedule to maximum extent possible

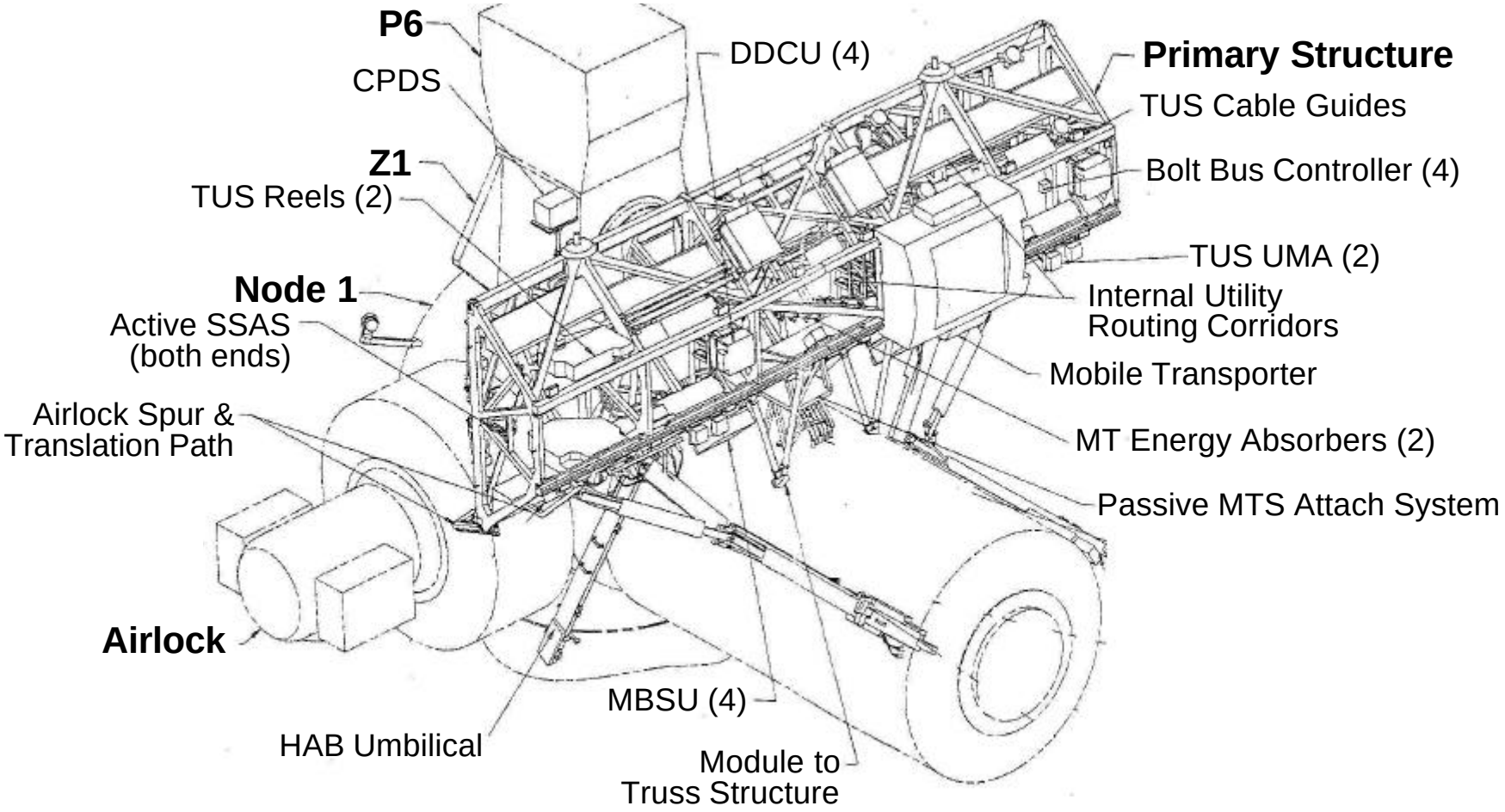
Flight 8A Upon Arrival



8A Post Undocking



S0 Integrated Truss



8A Significant Hardware

Cargo Bay

- S0 Integrated Truss Segment
- Mobile Transporter (MT)

MIDDECK

- ESEL (tool)
- EMU
  - **EMU (3 up, 1 exchange, 3 down)**
  - **EMU LiOH (18 CCCs)**
- Water Transfer Hardware
- O2 & N2 Transfer Hardware
- CHeCS Hardware
  - Formaldehyde Monitoring Kit
  - PCBA Cartridge Kit
  - Passive Dosimeter
  - Grab Sample Container
  - Grab Sample Container Re-supply

MIDDECK (cont'd)

- Utilization
  - Biomass Production System (BPS)
  - Biotechnology Refrigerator (BTR)
  - Biomass Production System (BPS)- Ames Stowage Kit
  - ARCTIC Freezer
  - CPCG-H
  - CGBA
  - Zeolite Crystal Growth-Sample
  - Protein Crystal Growth-Enhanced Dewar
- TVIS Chassis (Return only)
- ISS Return Hardware
  (Failed or out of certification)
- EVA Return Hardware
  (Failed or out of certification)

8A Mission Priorities

1. **Unberth S0 from the Shuttle PLB and complete minimum installation for S0 survival. These tasks must be completed during EVA 1.**
   a. Install S0 on LCA using SSRMS. [IVA] [Robotics]
   b. Connect Avionics Umbilical Trays or LTA cables using SSRMS and activate S0 survival power. [EVA] [Robotics]
   c. Install first Trailing Umbilical System (TUS) (using SSRMS) and activate Mobile Transporter (MT) survival power. Ground commanded OCRs associated with first TUS can be performed per Table H-3, Mobile Transporter On-Orbit Checkout Requirements. EVA] [Robotics]

2. **Deploy and install forward Module-to-Truss System (MTS) struts (using SSRMS) or any combination of adjacent 2 struts sufficient to support subsequent visiting docking/undocking loads.** [EVA] [Robotics]

Note: Priorities 1&2 must be completed or SO must be returned.

3. **Complete S0 installation.**
   a. Complete S0-to-Lab avionics trays, deployment of Aft avionics tray and connection of utilities (stow LTA cables if required) using SSRMS. [EVA] [Robotics]
   b. Deploy and install Aft MTS struts (using SSRMS). [EVA] [Robotics]

4. **Perform critical transfers.**
   a. Mandatory water quantities (Additional quantities transferred based on real-time assessment.) [IVA]
   b. O_2 and Nitrogen (N_2) to Airlock High Pressure Tanks (Approx. 125 lbs. Actual quantities to be transferred to be determined real-time or near real-time). (Not critical for docked EVAs) [IVA]

5. **Complete S0 activation and checkout. [IVA]**

8A Mission Priorities

6. Perform SSRMS power and data reconfiguration.

a. Install J300 Panel Power and Data Grapple Fixture (PDGF) connections (using SRMS). [EVA] [Robotics]

b. Install J400 Panel PDGF connections (using SRMS). [EVA] [Robotics]

7. Transfer ISS powered Utilization middeck payloads to and from ISS. [IVA] [Utilization]

8. Complete MT activation and configure for translation test.

a. Install second TUS (using SSRMS). Ground commanded OCRs associated with the second TUS can be performed per Table H-3, Mobile Transporter On-Orbit Checkout Requirements. [EVA] [Robotics]

b. Release launch restraints (using SSRMS). [EVA] [Robotics]

c. Complete EVA tasks (using SSRMS) for MT translation preparations and perform MT cam reset. [EVA] [Robotics]

9. Remove and stow S0 keel pins and drag links (using SSRMS). [EVA] [Robotics].

10. Translate MT from launch site to first worksite, per Table H-3. [IVA]

11. Install CIDs S0-2B (7) and S0-4B (8) on S0. [EVA]

12. Perform remaining payload transfers to and from ISS. [IVA]

13. Perform mission-specific transfers to and from ISS: crew provisions and supplies. [IVA]

14. Perform ITCS fluid sampling and return. [IVA]

15. Release LCA capture interface and the Loads Release Mechanisms (LRMs). [IVA] [EVA]

16. Install Airlock Spur (using SSRMS). [EVA] [Robotics]

8A Mission Priorities

17. Remove MT-to-Mobile Base System (MBS) bolt debris covers.

18. Perform MT translation test; both directions, per Table H-3.

19. Deploy External Vehicle-Charged Particle Directional Spectrometer (EV-CPDS).

20. Assemble and deploy Crew and Equipment Translation Aid (CETA) lights using SSRMS.

21. Install MT CETA energy absorbers using SSRMS.

22. Activate and checkout External Video Switch System (EVSWS)-1, 2, and 3. [IVA]

23. Perform Get-Ahead Tasks listed in order of priority.

a. Preposition EVA hardware and tools for UF-2. [EVA]

b. Assemble portable work platform on the SSRMS. [EVA] [Robotics]

c. Remove four (4) Z1 Shrouds from Z1 and stow them on the Z1 truss. [EVA]

d. Depress each of three (3) Segment to Segment Attachment System (SSAS) Ready to Latch (RTL) indicators on the S0 Port and Starboard SSAS interfaces (using the SSRMS). [EVA] [Robotics]

e. Remove DDCU 4B MLI cover. [EVA]

f. Install Joint Airlock Handrail (1). [EVA]

g. Install S0 Handrails (5) (using the SSRMS). [EVA] [Robotics]

h. Deploy Node 1 Swing Arm Tray. [EVA]

24. Perform Main Bus Switching Unit (MBSU)/DDCU power on test. [EVA] [IVA]

8A Mission Priorities

25. Reconfigure LTA cables. [EVA]
26. Perform Structural Dynamic Measurement System (SDMS) data take to verify Signal Conditioner Unit (SCU) functionality. [IVA]
27. Perform SDTO 15004-U, ISS Control of Partial Pressure of Carbon Dioxide Levels in the Space Shuttle to Reduce LiOH Usage. (Additional details for the SDTOs are documented in SSP 50448.) [IVA] <TBR 6-13>
28. Perform DTO 263, Reboost tuning. [IVA]
29. Perform SDTO 13005-U, ISS Structural Life Validation and Extension, during SSRMS operations with S0. (Additional details for the SDTOs are documented in SSP 50448.) [IVA]
30. Perform SDTO 13005-U, ISS Structural Life Validation and Extension, during SSRMS operations with S0. (Additional details for the SDTOs are documented in SSP 50448.) [IVA
31. Perform SDTO 13005-U, ISS Structural Life Validation and Extension, during S0 installation. (Additional details for the SDTOs are documented in SSP 50448.) [IVA]
32. Perform SDTO 13005-U, ISS Structural Life Validation and Extension, during EVA activity. (Additional details for the SDTOs are documented in SSP 50448.) [IVA]

ISS 8A Consumables Status

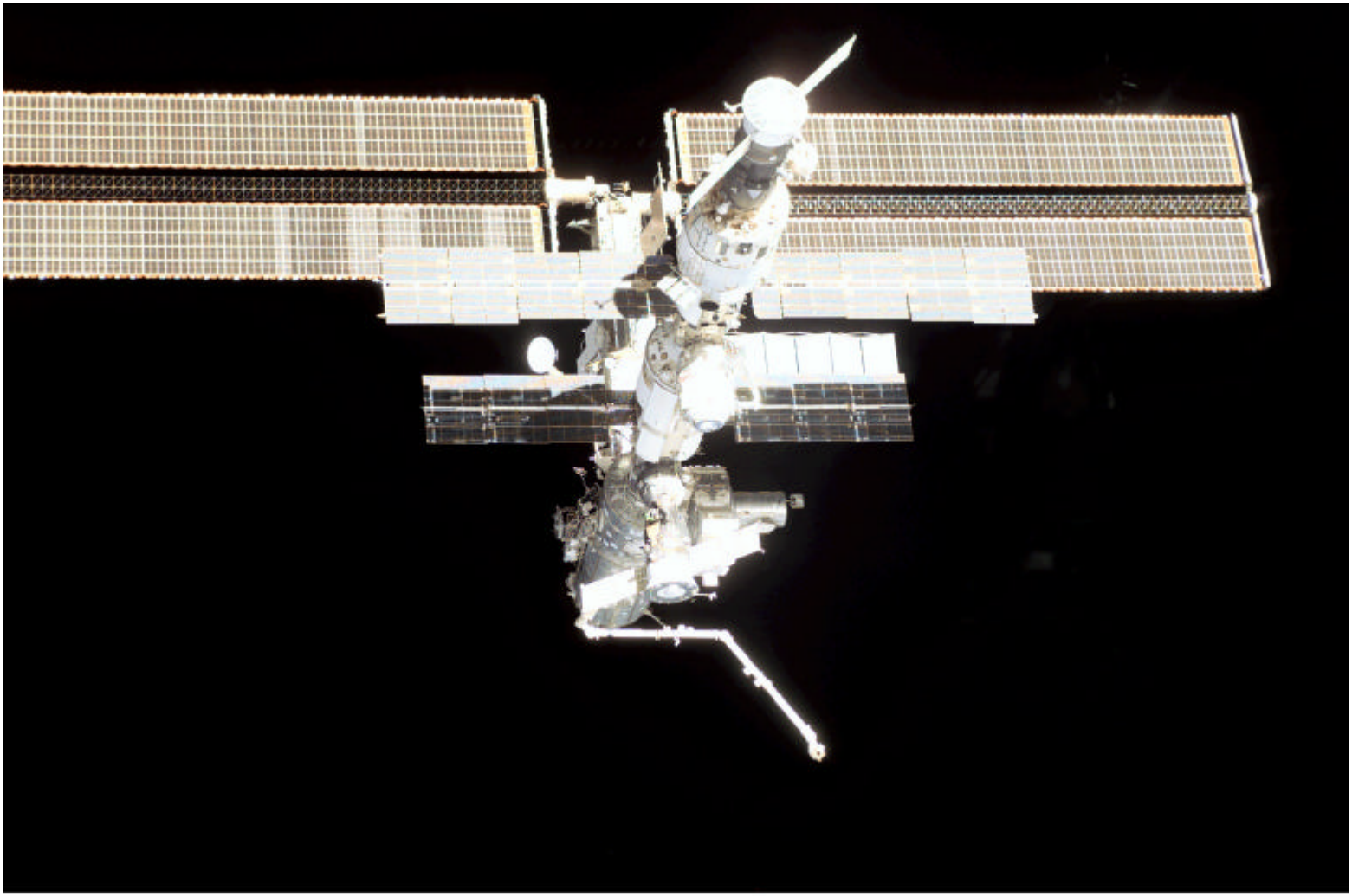
- **All consumables have been reviewed and are healthy for the 8A Stage.**
  - Only Flt 8A consumable re-supply to ISS: Water
  - ISS propellant reserve requirement is met.
  - Food will remain above skip cycle.
    - **Food will still remain above skip cycle if UF-2and 8P slip to August.**
  - EDV,KTO, KBO and SWC requirements are still met if UF-2 and 8P slip to August.
  - Oxygen Cassettes are maintained at above the skip cycle throughout the stage for maintenance protection. (Backup to ELEKTRON).
  - LiOH is above the skip cycle (Backup to VOZDUKH and CDRA).
  -
  - Crew Provisioning requirements are met.
  - Water is maintained at well above the skip cycle throughout the stage.

Launch Commit Criteria

- 8A Cargo Element Launch Commit Criteria
  - None
- ISS Stage Driven Launch Commit Criteria
  - **Software:** CCS, MSS, and GNC R2 uplinked and verified running nominally. **Completed**
  - **SSRMS:** Single fault tolerant SSRMS and RWS systems (including power command and control capability) and successful completion of mandatory pre-8A SSRMS checkout activities per rule {6a_2c-19}, SSRMS checkout priorities. **Scheduled for completion prior to L-2.**
  - **Airlock:** Single fault tolerant joint airlock systems and successful completion of mandatory pre-8A airlock checkout and prep activities. **Completed**
  - **LCA:** Single fault tolerant LCA (for IMCA and RPCM) and successful completion of mandatory pre-8A LCA checkout activities. **Completed**
- Standard Generic Launch Commit Criteria
  - **Orbiter: Minimum equipment list plus.**
    - 1 of 2 Payload communication strings
    - 1 of 2 OIUs
    - PDI
  - **ISS On-Orbit:**
    - Single fault tolerant for:
      - Docking attitude and rate constraints
      - Command and control over all critical systems
      - Berthing mechanisms required for category 1 objectives
      - Thermal control for critical systems
      - SSRMS and RWS systems required for category 1 objectives
    - Propellant for all category 1 and 2 objectives
    - Power sufficient to complete all planned objectives & ensure survival of critical ISS systems through the stage
    - At least one operational communications and telemetry system
    - At least one S/G voice comm system
    - ISS habitable atmosphere
  - **Ground System requirements**

All on-orbit checkouts planned for completion prior to L-2.

Flight UF-1 Configuration



Hardware Status
(Recent Developments)

Issues	New Since UF-1 SORR	Impact to 8A Operations	Topic to be Presented	Additional Ground Testing or Open Work	On-Orbit Repair scheduled or required
BGA Rotation High Current	Yes	No	Yes	No	No
Loss of Attitude Control	Yes	No	No	No	No
METOX	Yes	No	Yes (EVA)	Yes	No
Loss of Comm	Yes	No	Yes (Avionics)	Yes	No
ITCS Contamination	Yes	No	Yes	No	No
DDCU Misconfiguration	Yes	Yes	Yes	No	No
O2/N2 Transfer Issues	Yes	No	Yes	No	Yes
R2 Upload	Yes	No	No	No	No
TVIS	Yes	No	No	Yes	Yes
SM ARCU #23	Yes	No	No	No	Yes
SM Window Chip	Yes	No	No	No	No
Node SD #2	Yes	No	No	No	No
UF1- Pressurization	Yes	No	No	No	No

Hardware Status
(On-Going Issues)

Issues	New Since UF-1 SORR	Impact to 8A Operations	Topic to be Presented	Additional Ground Testing or Open Work	On-Orbit Repair scheduled or required
MCA Operations	Yes	No	No	No	Yes
Vozdukh Operation on 2 of 3 CO_2 Beds	Yes	No	No	No	Yes
SM Rapid Depress Algorithm Disabled	Yes	No	No	Yes	Yes
SM Air Conditioner #1	Yes	No	No	No	Yes
CMG- Outer Gimbal Bias, Current Spikes, Loss of comm	Yes	No	No	No	No
RPCM Health Flags	Yes	No	No	No	TBR

What is Out of Configuration

- Three RPCMs that cannot be refreshed - no impact
- EEATCS starboard radiator - one loop plumbed incorrectly - no impact
- 1 of 4 Beta Gimbal Assembly (BGA) latching mechanisms not locked on starboard 4 bar assembly - no impact
- Vozdukh operating on 2 of 3 CO_2 beds - no impact to CO_2 removal
  - Second vacuum pump starting to fail; planning R&R
- CDRA operates on single bed - no impact
- SM rapid depress algorithm disabled - no impact (Lab provides function)
  - Russians currently enabling the algorithm during the crew day
- MCA has limited life - will be managed operationally
  - Currently MCA is not operating
- TVIS – temporarily have restricted operations to less than 6 mph
- Air Conditioner SKV#1- not operating

BGA Status

- 4B in directed position
- 2B in Autotrack while flying XVV
  - 2B has experienced high current events and one stall since last flight
- Blankets installed on UF-1 were not effective in mitigating events
- Plan to limit the number of rotations on 2B as much as possible
  - Low Beta XPOP required (ECD TBD)

ITCS Contamination

- ITCS fluid samples have shown microbial growth and decreasing pH
- Silver Biocide filters were installed post UF-1
  - On-orbit fluid samples have indicated silver biocide filters working
  - Water samples to be returned on 8A for more complete testing
- Have developed a kit for adjusting the pH level back to appropriate levels
  - Will be injecting NaOH directly into the ITCS loop
  - Hardware will be ready by mid March

DDCU Misconfiguration

- One of the objectives of the US UF-1 Stage EVA was to check out the DDCUs that are to power S0
- It was discovered during the EVA that the DDCUs were not configured as expected
  - The DDCUs were configured for parallel operation (12A.1 configuration) as opposed to single operation (8A configuration).
  - The s/w expected single DDCUs and, thus, no commanding was possible to the DDCUs
- Post EVA activities have corrected the DDCU configuration
- There are impacts to the first 8A EVA to reconfigure CIDs 5 and 6 that were left closed during the Stage EVA

On-Orbit Summary

- None of the identified items for investigation regarding the on-orbit configuration represent a constraint to the flight of 8A

- The MER personnel and facilities will be ready to support

Current On-Orbit Status

- C&DH
  - All Station MDMs operating
    - Node - N1-2 primary, N1-1 secondary
    - Photovoltaic Control Unit (PVCU) - 2B backup, 4B primary
    - FGB - 1 on, 2 off
    - SM - Loaded with version 5.0 software
      - SMTCs - all in redundant set
      - SMCCs - all in redundant set
    - Lab
      - C&C 1 primary, C&C 2 backup, C&C 3 standby
        - SSMMUs installed
        - R2 Upload complete
      - INT systems 1 operating, INT systems 2 off
      - Lab Aft 1, 2, 3 operating
      - Power Management Controller Unit (PMCU) 1 off, PMCU 2 on
      - GNC 1 backup, GNC 2 primary
      - Payload 1 off, PL 2 primary

Current On-Orbit Status
(continued)

- C&T
  - S-band high/low data rate operating nominally
  - Ku band operating nominally
  - MCOR operating nominally
  - SM Regul System operating on 1 of 3 strings
  - Audio system
    - Internal Audio Controller (IAC) 2 active, IAC-1 off
    - Have occasional P-bits on audio equipment
  - VTR #2 has been cleaned and is functioning properly

Current On-Orbit Status
(continued)

- ECLS
  - Lab ECLS systems operating nominally except for the CDRA and MCA
    - CDRA operating single-bed (when required)
    - MCA currently non-operational
  - Node smoke detector #2 R&R'd but system not yet operational
  - SM Vozdukh operating on 2 of 3 CO2 removal beds
    - CO2 removal capability nominal
    - Second vacuum pump starting to fail
  - Air conditioner #2 (SKV 2) is up; air conditioner #1 (SKV #1) is down
    - Freon in atmosphere being scrubbed by the Russian micropurification unit (BMP)
  - SM rapid depress response inhibited
    - Russian have recently been enabling the algorithm during the crew day
    - Low pressure warning enabled
      (U.S. Lab rapid depress response enabled)

Current On-Orbit Status
(continued)

- EPS
  - FGB EPS working nominally
    - 5 of 6 batteries on-line
  - SM EPS working nominally
    - 7 of 8 batteries on-line
  - P6 power channels 2B and 4B operating nominally
    - 4B in directed position; 2B in rotated as required for power
  - RPCMs
    - RPCM LAD22B-A has a bit flip in SRAM - cannot be refreshed (spare available if required)
    - RPCMs LAFWD-1B-A and LAFWD-1B-C cannot be refreshed. No short term impact. Long-term plan in work. Expect to R&R RPCMs
  - CIDS 5&6 closed due to DDCU configuration problem during test performed during last EVA. Will need to be configured to support 8A operations
  - SM ARCU #23 declared failed. Russians planning to R&R.

Current On-Orbit Status
(continued)

- S&M
  - 3 of 4 Beta Gimbal Assembly (BGA) latching mechanisms locked on starboard 4 Bar assembly
    - Latched port 4 Bar assembly on 5A.1
    - Strength analysis shows 3 of 4 acceptable for near term
  - 2B and 4B BGA showing high currents sporadically
    - When in XVV, 4B in directed position (to limit use), 2B in autotrack
    - Low β X-POP planned to limit 2B rotations
  - Impact mark on SM window #7

Current On-Orbit Status
(continued)

- TCS
  - Early external active thermal control system operating within specs
    - Starboard radiator has one loop plumbed incorrectly
      - Heat rejection capability impacted - still meets current heat rejection needs
  - ITCS operating nominally (see Special Topic)

- EVR
  - CanadArm2 operating nominally
  - RWS has one monitor failed
    - Replacement to be flown on UF-2
  - Have experienced a brake voltage failure on the Prime String
    - Still assess impacts

Current On-Orbit Status
(continued)

- GN&C
  - All CMGs have experienced occasional loss of comm
  - CMG 2 has a 24.5 deg bias in the outer gimbal

- Propulsion systems nominal and ready for 8A operations

Current On-Orbit Status
(continued)

- EV&CS/GFE Hardware
  - VOA (air sample analyzer) - not operational
    - 3-4 month system validation process not started due to problems
  - TOCA (water sample analyzer) - validation in progress, issues resolved
  - TEPC (radiation monitor) - working
    - Experiences occasional downlink of data problems
  - Defibrillator - working
  - IRED, CEVIS - working
  - TVIS - power failure under investigation
  - IV-CPDS - gives anomalous dose readings
    - Experiences occasional downlink of data problems
  - Water Maintenance Kit (WMK) - “contamination” understood, kit useable

Mated QD Hydraulic Lockup

8A FRR

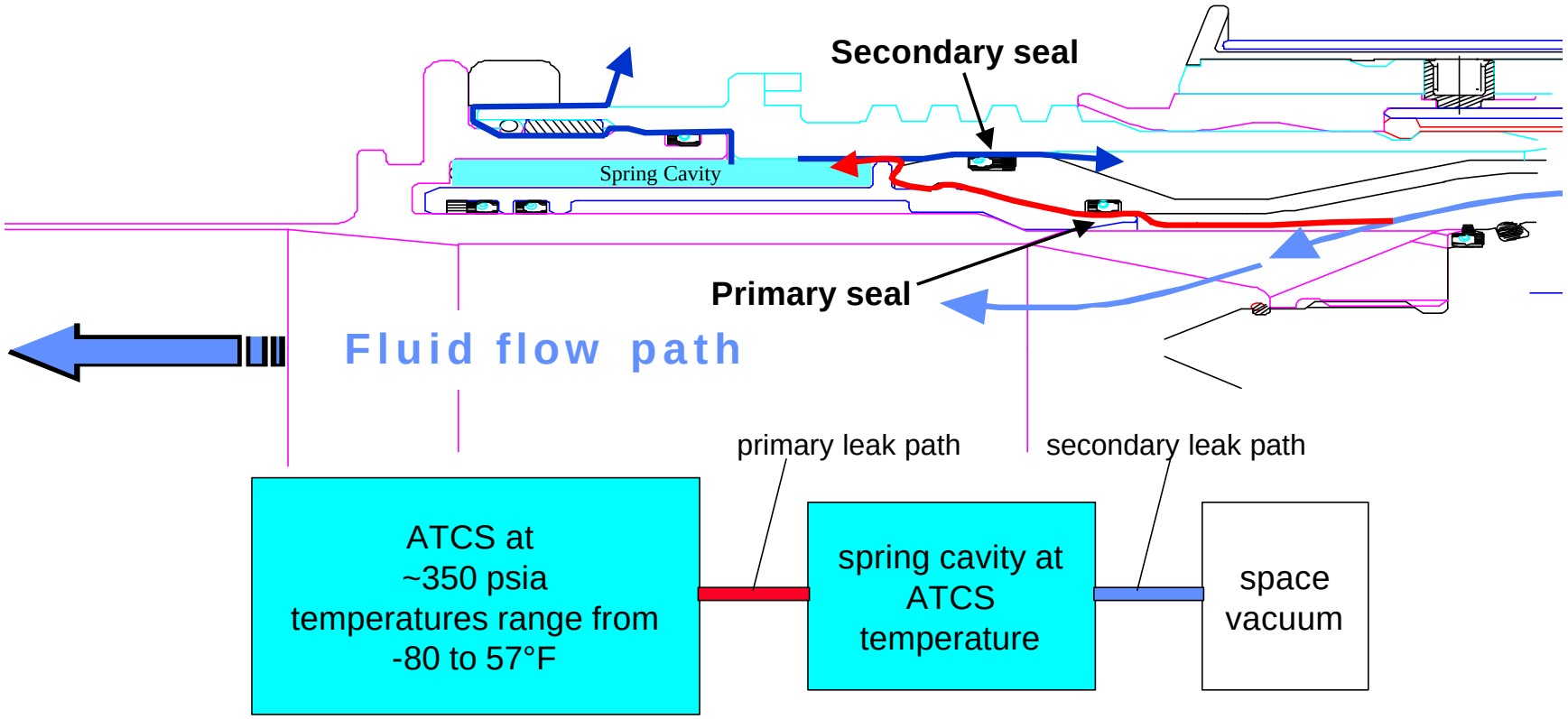
March 26, 2002

Outline

- Problem Description
- Consequences
- Flight Readiness Logic Path
- Risk Assessment and Risk Mitigation Summary
- Confidence in S0 QDs
- EVA Assessments
- Conclusions/Recommendation

Problem Description
Spring Cavity Filling

- **Any mated and open ammonia quick disconnect (QD) in the ISS External Active Thermal Control system may experience a pressure buildup in the male QD spring cavity which could result in damage to the QD**



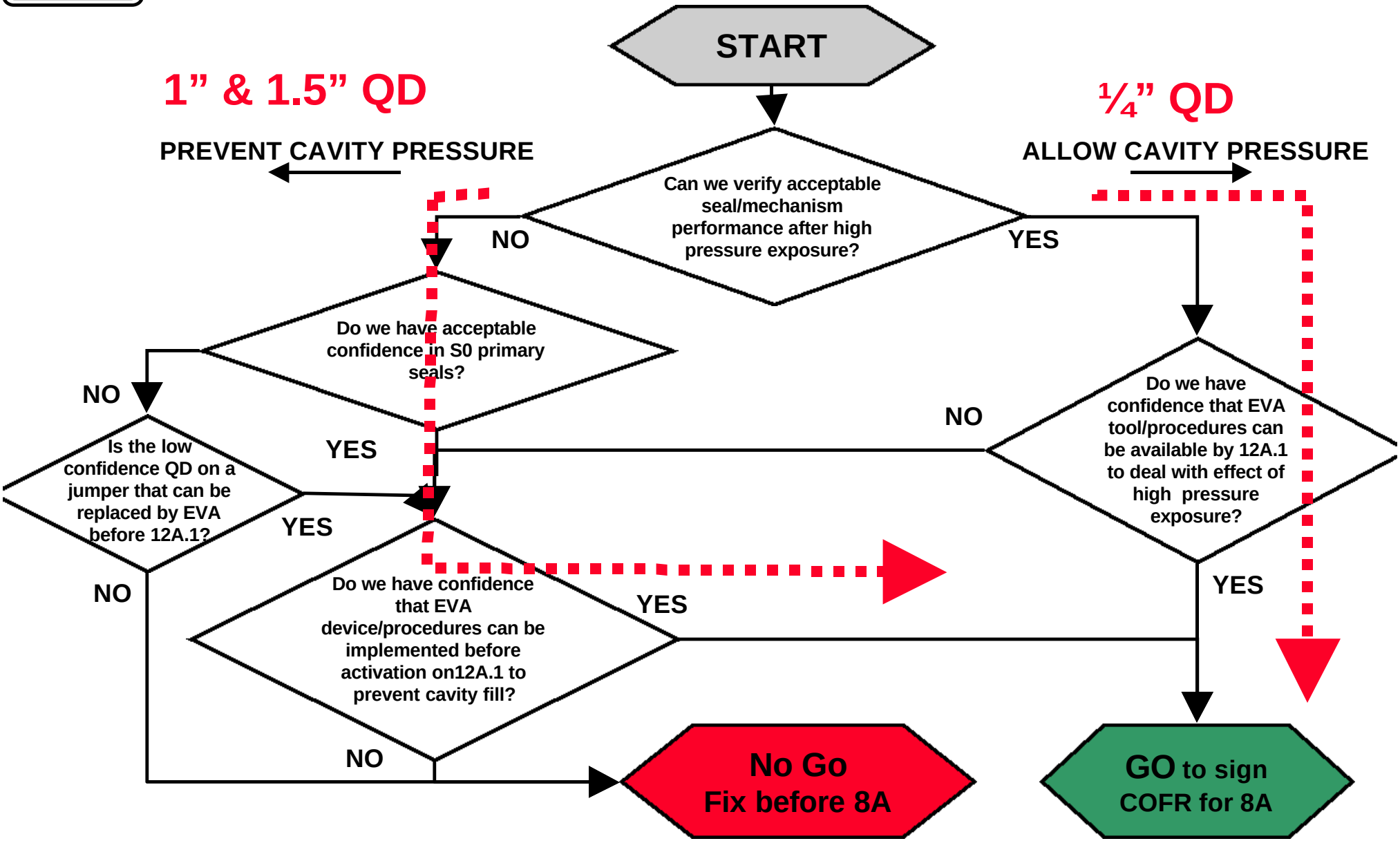
- Vapor fills spring cavity until pressure reaches saturation at system temperature
- Liquid fills spring cavity until hard packed
  - Could take from several months to many years - *depends on primary & secondary seal leakage performance*
- Increase in temperature results in overpressure condition

ISS-B.2-3

Possible Consequences of High Pressure in Male Spring Cavity
(definitions)

- **Burst -** Ultimate failure of male QD structure
- **Auto Detent/Depress**
  - Detent button self-depresses causing QD to close
  - Results from QD mechanism loading and localized deformation
- **Jam Events**
  - Jam events result in high detent button and bail forces – after either jam event, forces to operate button and bail are higher due to binding within mechanism
    - Partial Jam - Onset of plastic deformation of QD dog bone groove ;secondary seal still sealing
    - Complete Jam - End product of partial jam, where secondary seal has unseated and no longer seals
- **Male stuck open - current evidence points to this being non-credible**
  - Male sleeve not following female spool during Jam event, resulting in gross overboard leak
- **Compromised Seal Integrity -** Primary and/or Secondary seal performance loss due to permanent deformation

Flight Readiness Logic Path



Risk Assessment and Mitigation Summary

- **Risk Assessment - Based on QD test, analysis and inspection**
  - 1/4” QD design precludes all damaging events but can result in increased detent button depress forces
  - 1” and 1.5” QD design susceptible to damage that must be prevented
- **Risk mitigation - Strategy assessed**
  - Develop EVA detent button depress tool for 1/4” QD to address non-detrimental spring cavity pressure
  - Develop EVA installed cavity fill prevention device for 1” and 1.5” QDs
    - Device is a bail positioning device which statically positions female QD spool to unseat secondary seal while device is installed
  - Assessed system operation with secondary seal defeated - *no impact*
    - Change to QD pressure drop assessed and determined to be negligible
    - Does not impact ability to provide minimum ammonia flow to heat exchangers and external cold-plated DDCUs/MBSUs - *no impact to heat rejection*

Confidence in S0 QD Primary Seals

- **Comparison with S1 and P1**
  - All 1” and 1.5” QDs on S0 were inspected prior to closeout -- no evidence of seal damage or contamination
  - All QDs on S1 and P1 were inspected prior to closeout – no evidence of seal damage or contamination
  - 17 primary seal only tests conducted on S1/P1
    - 1” and 1 ½” data from 1.2×10^{-5} to 4.5×10^{-4} sccs He @ 500 psid – most data in the lower end
- **Strong correlation of passing visual inspection to leak rates less than 1×10^{-3} sccs He**
- **Inventory**
  - Current ammonia inventory plan capable of additional ~8 lbm/yr overboard leakage per loop (total 16 lbm/yr for each loop)
    - Could gain an additional 100 lbm of NH3 if don’t fill the third radiator
  - Capability equivalent to maximum leak rate of $>3.4 \times 10^{-3}$ sccs He (34 x spec) at each of 24 QD’s
    - Allowable leak rate 3.4x value inferred from visual inspection
    - Allowable leak rate 7.5x maximum measured value on S1/P1
    - Allowable leak rate 50x average measured value on S1/P1
  - Capability exists to augment inventory plan if required through additional EVAs
    - Accelerate first ATA re-supply
    - Increase frequency of planned re-supply

1/4 inch QD
Result = Design Precludes All Damaging Events

Burst

23576 psi (analysis)
→ **Has not been observed**

Auto Button Depress (self close)

Greater than 8600 psi (Feb. 18, 2002 test)
→ **Has not been observed**

Pin Jammed

Initiation: 5000 psi

Completion: 8600 psi

(Feb. 18, 2002 test)

Male Sleeve Stuck Open

If possible, at onset of Pin Jam, > 5000 psi

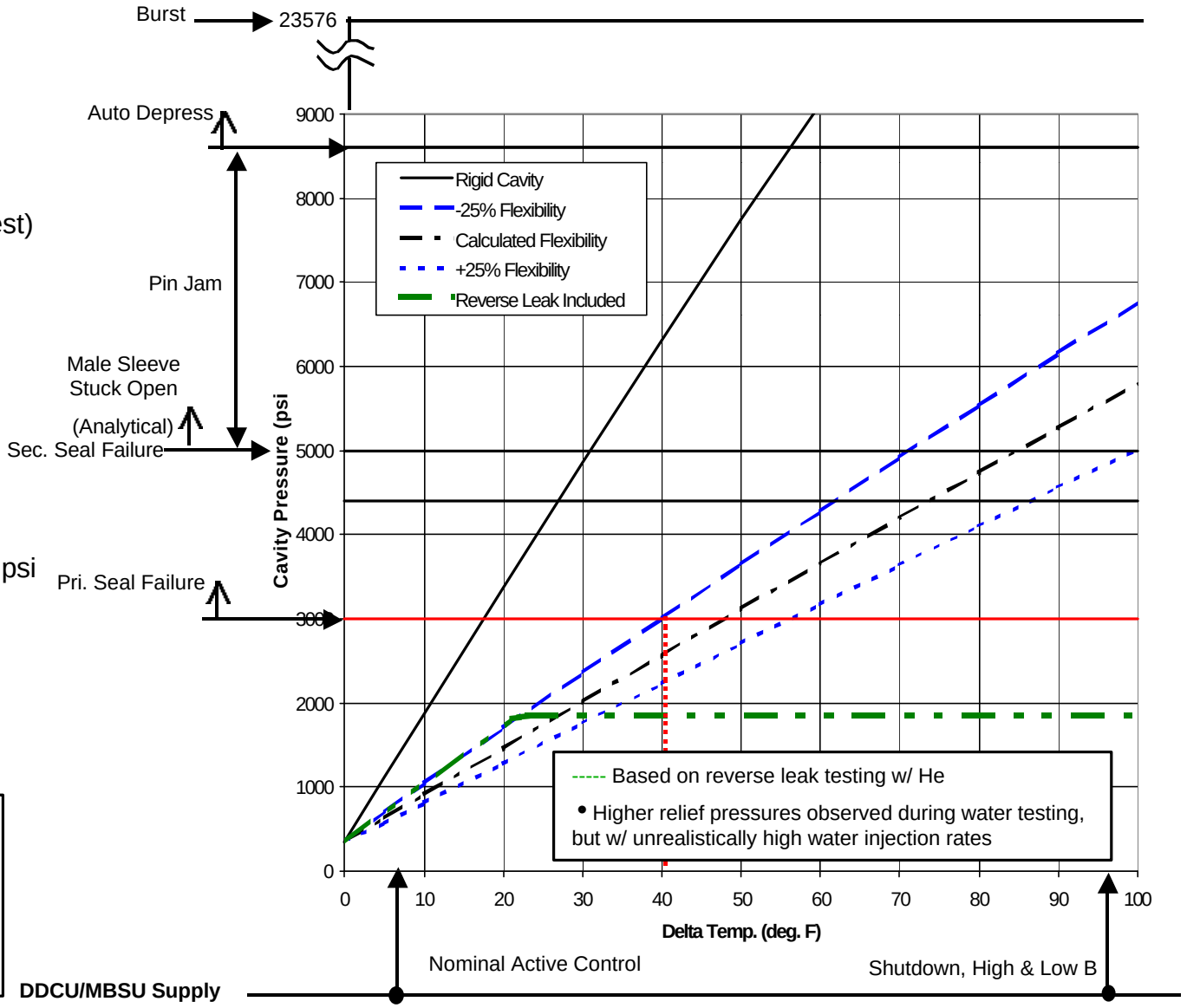
Compromised Seal

Primary > 3000 psi (March, 2002 test)
→ **Has not been observed**

Secondary ≥ 5000 (Feb. 18, 2002 test)

All data, except that labeled "Reverse Leak Included", assumes spec. leak primary and perfect secondary.

Reverse Leak Data used is the highest relief pressure of 7 tests, utilizing 3 diff. pri. seals (cavity "relieves at" approx. 1850 psi)



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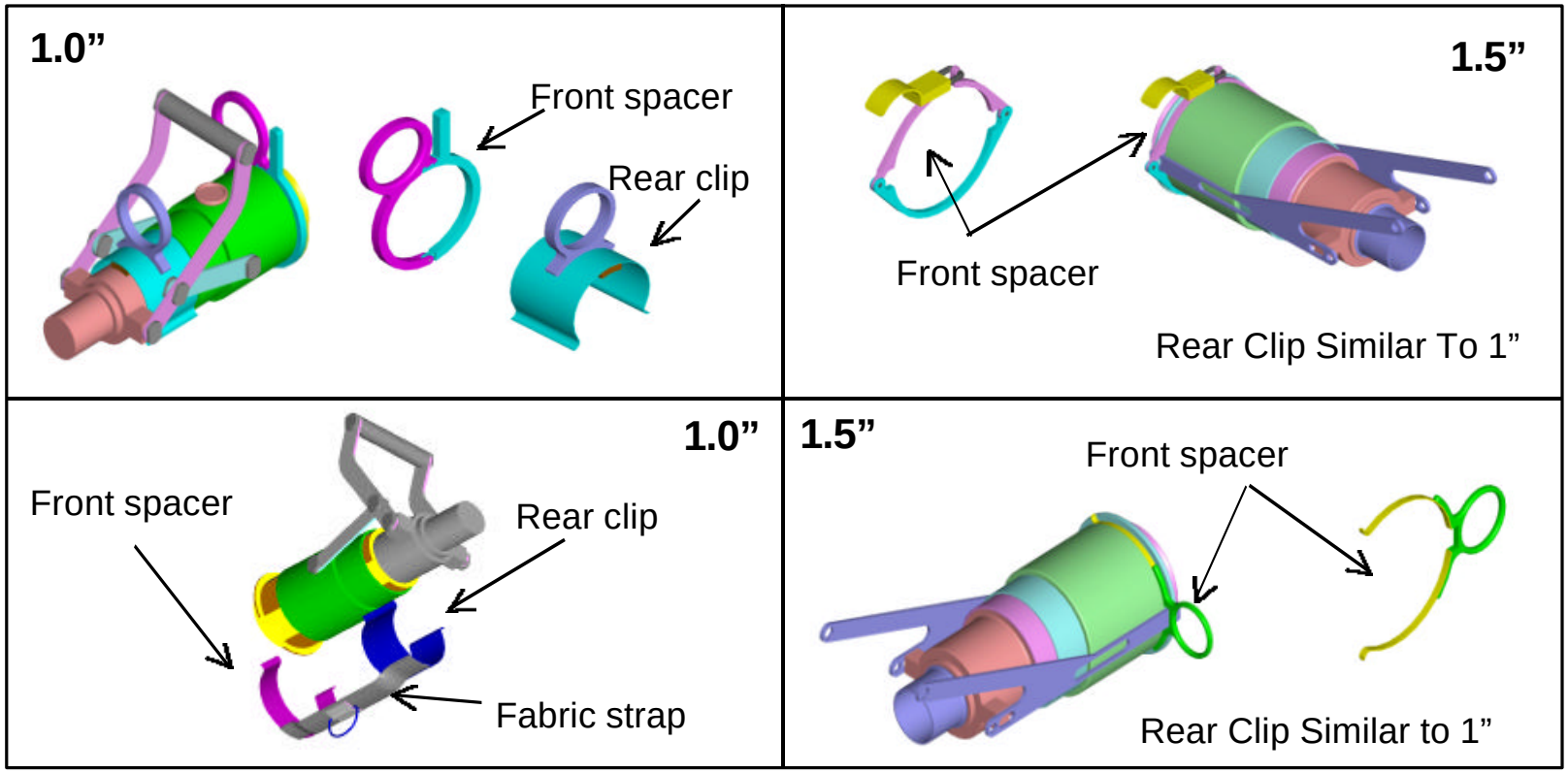
EVA Spool Positioning Device Concepts

EVA Project Office

- **The EVA team has developed feasible concepts for 1.0” and 1.5” spool positioning devices**
  - While opening QD, EVA installs a front spacer to prevent secondary seal engagement
  - After the valve is opened, EVA installs a rear clip to prevent valve closure



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EVA Spool Positioning Device Installation

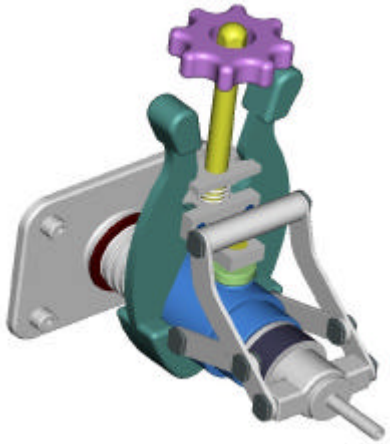
EVA Project Office

- **All spool positioning devices must be in place prior to NH_3 exposure at 12A.1 or Stage 10A**
  - All but six are exposed to NH_3 during 12A.1 EVA#4 EATCS activation
  - The six Node2 Rigid Umbilical QDs are launched unmated and are not exposed to NH3 at 12A.1. They are mated to S0 and opened to NH_3 flow during Stage 10A Node2 EVAs.
- **Devices can be installed on sixteen of twenty 1.0" QDs with minor timeline impact**
  - 4 can be installed during connection of S0-Lab Umbilicals during 12A.1 EVA#4
  - 12 can be installed during connection of Node2 Rigid Umbilicals during Stage 10A EVAs
- **Devices can be installed on four of twenty 1.0" QDs with at most one new EVA**
  - There is no planned access to the 4 Node2 Shunt Jumper QDs prior to NH_3 exposure at 12A.1
  - Device installation will be planned as a get-ahead task subsequent to hardware availability
  - If not complete as a get-ahead task, one new EVA will be needed prior to 12A.1 EVA#4
- **Devices can be installed on all eight 1.5" QDs with at most one new EVA**
  - 4 can be installed during connection of S0-S1 Jumpers on 9A EVA #1 if devices are available
  - 4 can be installed during connection of S0-P1 Jumpers on 11A EVA #1 if devices are available
  - If hardware is not available for 9A/11A, installation will be planned as get-ahead task on subsequent flights
  - If not complete as a get-ahead task, one new EVA will be needed prior to 12A.1 EVA#4.

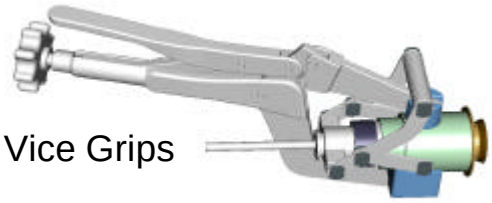
Button Depress Tool Concepts and Use

EVA Project Office

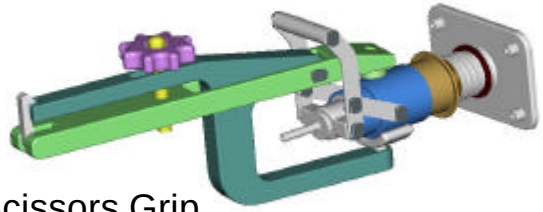
- **The EVA team has developed feasible concepts for a ¼" button depress tool**
  - Load limitations within the QD prevent unloading the button prior to depress.
  - Tool must overcome worst case button depress forces of ~700lbf
- **Operational impacts are acceptable**
  - Adequate tool clearance and hand access are available at all locations
  - Tool is only used during contingency coldplate replacement (MTBF ~80 years).
  - Earliest possible coldplate replacement is after ammonia fill during 12A.1 EVA#4 .
  - Use of the tool increases task time by up to 1 hour and does not cause a new EVA.



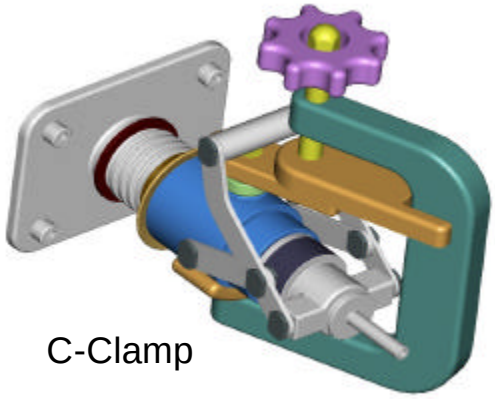
Pusher Clamp



Vice Grips



Scissors Grip



C-Clamp

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Conclusions and Recommendation

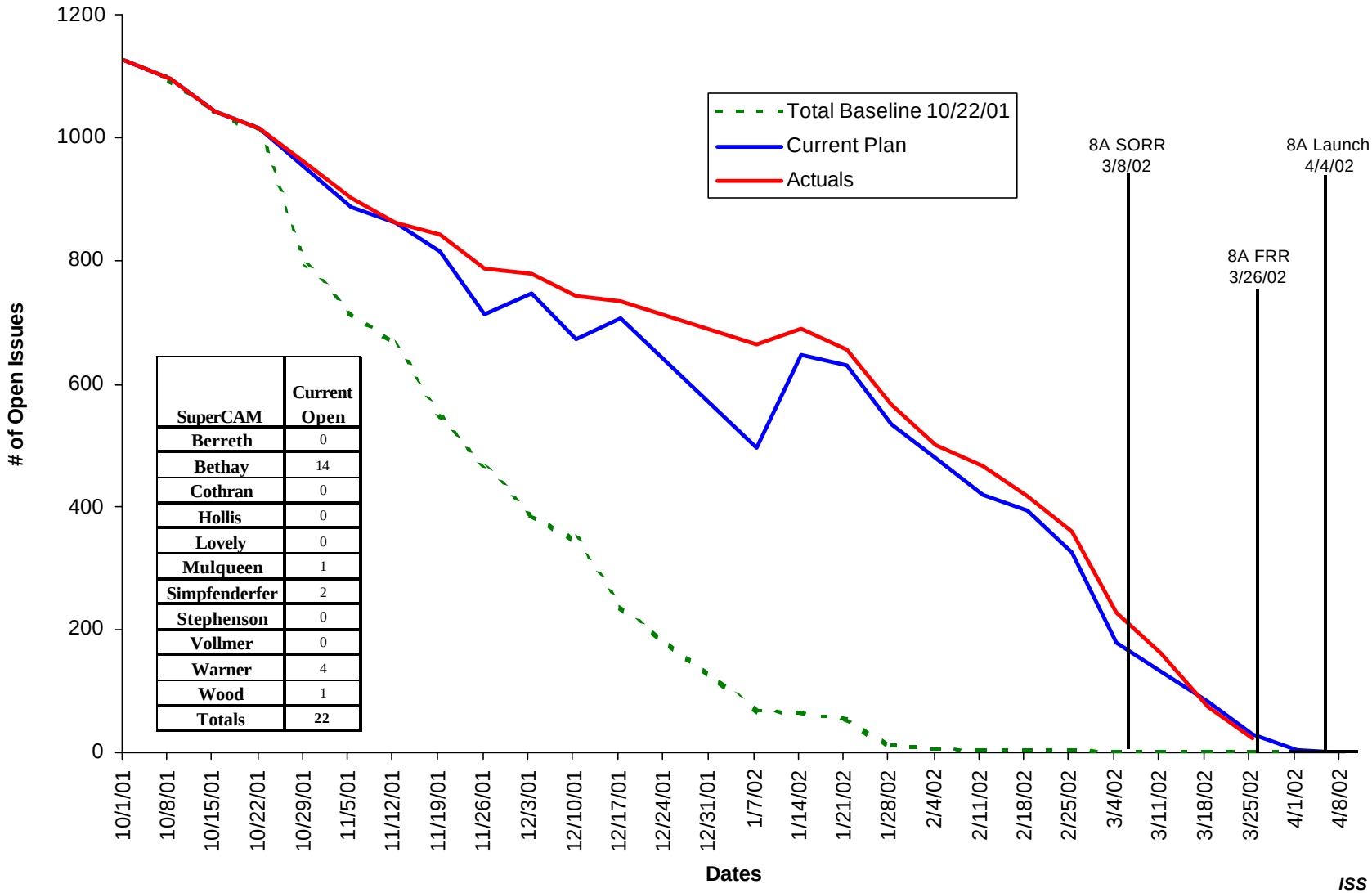
- **Negligible impact to system performance and minimal impacts to EVA timelines**

- **Good confidence in completing the following (acceptable risk):**
  - Tools & devices in time for need
  - Re-verification of QD configuration & usage prior to activation
    - Risk associated with open re-verification work evaluated and acceptable

- **Waivers/NCRs developed to address increased spring cavity MDP and use of single seal ops**
  - Final waiver approval ECD 3/25/02

8A acceptable for flight

8A Burndown



SuperCAM	Current Open
Berreth	0
Bethay	14
Cothran	0
Hollis	0
Lovely	0
Mulqueen	1
Simpfenderfer	2
Stephenson	0
Vollmer	0
Warner	4
Wood	1
Totals	22

03/25/2002 12:16:07 PM

8A Open Paper

- FEP - Bethay – 14
  - (4) Open Planning – Last ECD 3/26/02
  - (10) Non Conformances – Last ECD 3/26/02

- Struc & Mech - Mulqueen – 1
  - FCA/PCA/ARs
    - 222200A-AR1-013 – ECD 3/26/02
      - Held for completion of ATPs at KSC ECD 3/25

- Software – Simpfenderfer - 2
  - (2) FCA/PCA Actions
    - Data reviewed is satisfactory, minor documentation cleanup, no constraint to launch
      - EXT SPDR Action - ECD 3/26/02
      - S0 SPDR Action – ECD 3/26/02

8A Open Paper

- S&MA - Warner – 4
  - (1) NCR
    - NCR-ISS-090 – ECD 3/25/02 - Symmetrics QD seal cavity overpress
  - (3) VTLs
    - GNC-701-03-01.b-8A - Awaiting NASA DAP stability analysis (Rob Hall) – ECD 3/25/02
    - 2 Mech VTLs awaiting Boeing-HB Safety closure
      - MCH-50-01-02.c.7-8A - Awaiting VR run on 3/25/02 to verify S0 restow – ECD 3/25/02
      - MCH-50-03-02.c.1-9A - Awaiting resolution of SSAS contingency PRD attachment to CETA Cart (Greg Lestourgeon 483-3444)
    - Note: Safety expects to open a new VTL for SSRMS wrist roll joint software patch verification – ECD 4/2/02

8A Open Paper

- TECS - Wood – 1
  - (1) PRACA
    - 2866 - ECD 3/26/02
      - A plan is being worked by the ITCS SPRT with JSC to provide a method of increasing the pH during the 8A stage, need to Develop (syringes) Kit and ship to KSC before clearing this PRACA for 8A. Kits scheduled for shipping back to KSC. NEW SAR and STS-110/8A delivery milestones. Quantity two INIK kits were delivered to USA FCE/EVA on Wed, 20 MAR 2002. This date has been agreed to by STS-110/8A LPM (OC/Ben Sellari) and concurred by USA Mission Manager (USA/Terry Quick). Bench Review scheduled for 3/26/02 at JSC then to be shipped to KSC by 3/29/02. (The PRACA ECD 6/3/02) Mike Holt will sign off for 8A after the Bench Review.

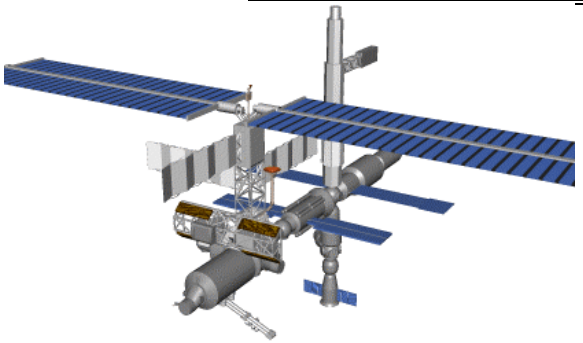
Avionics and Software
8A Flight Readiness Review

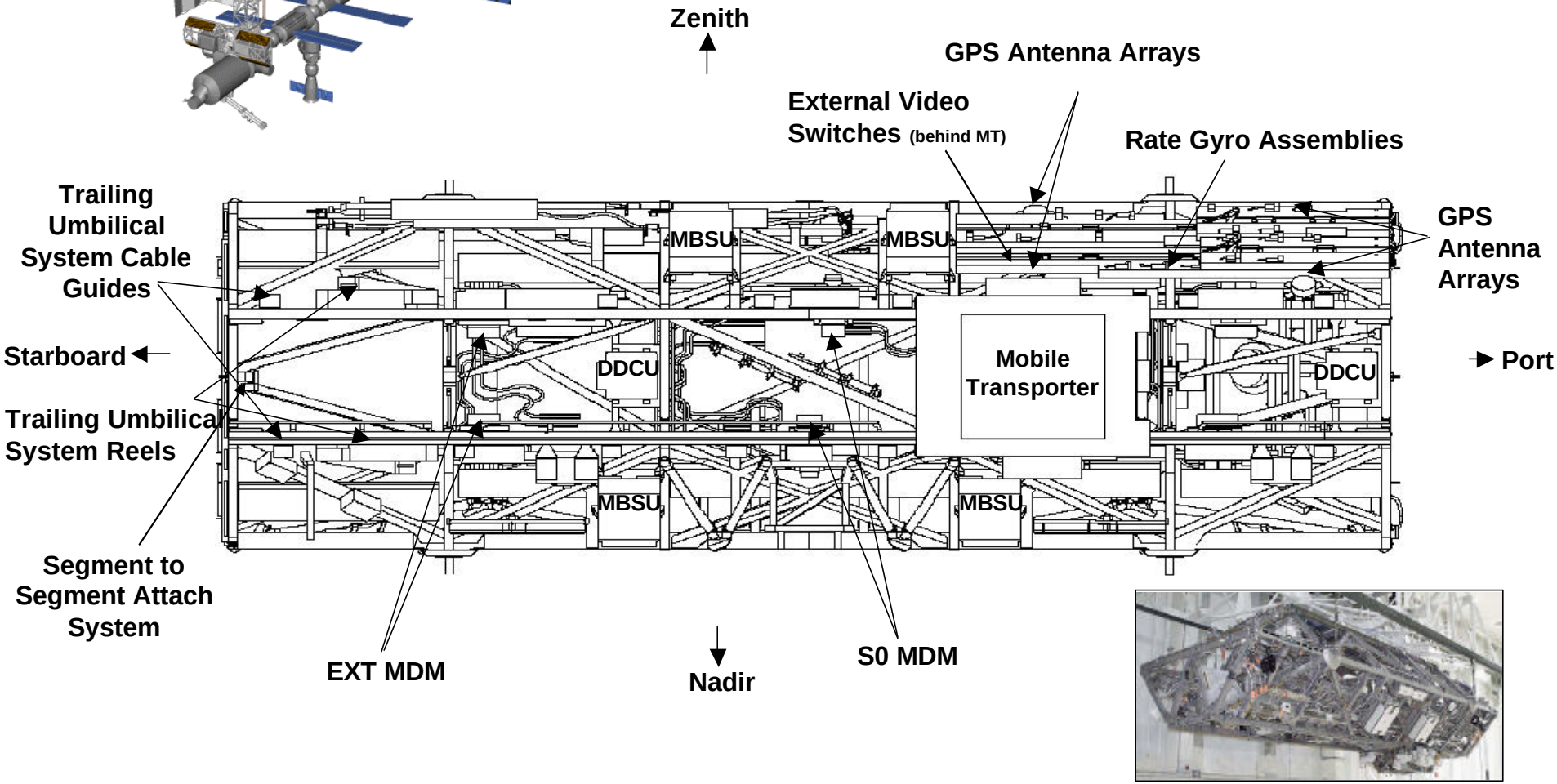
Peggy Thomas
March 26, 2002

Agenda

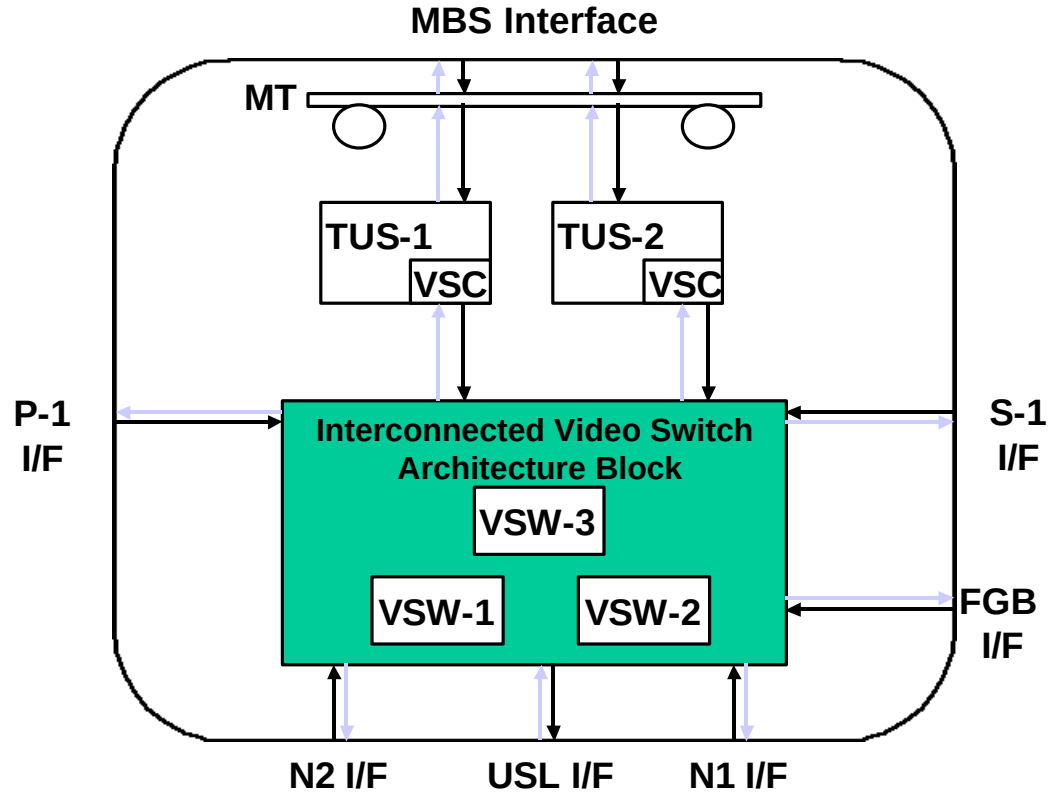
- Avionics and Software Element Overview
- Avionics Hardware Readiness
  - New Hardware and Added Functionality
- Flight Software Readiness
  - New Flight Software and Added Functionality
  - Station Program Notes
- Integrated Test Activities
- Facility Readiness

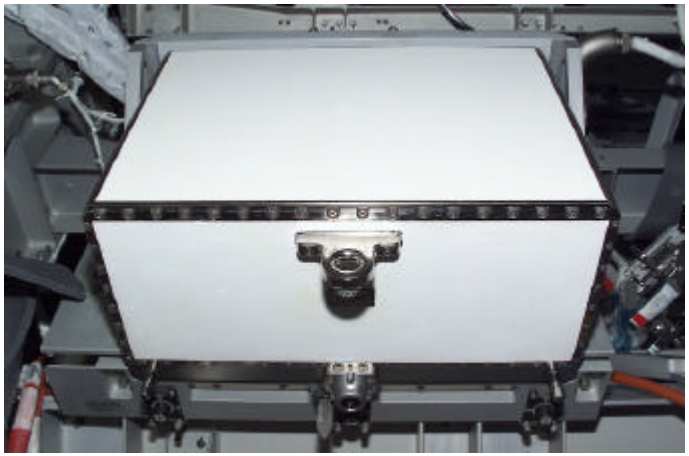
Avionics and Software Element Overview





Communications and Tracking
Three Video Switches Deployed



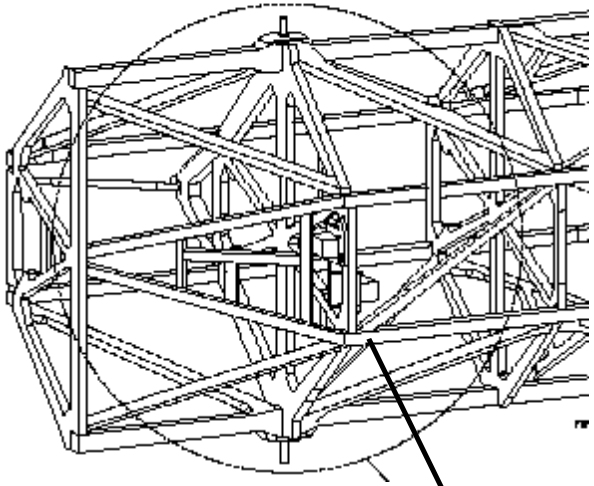


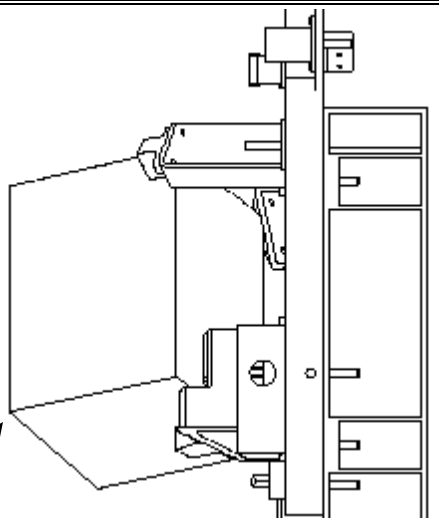
External Video Switch (VSW)

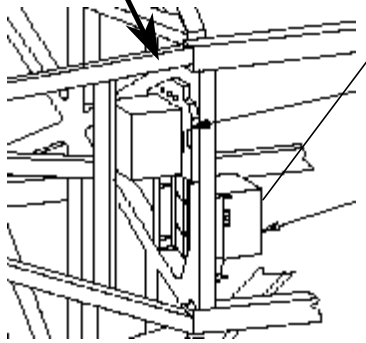
Provides for routing of video and sync signals from cameras to robotics workstation video recorders and the ground

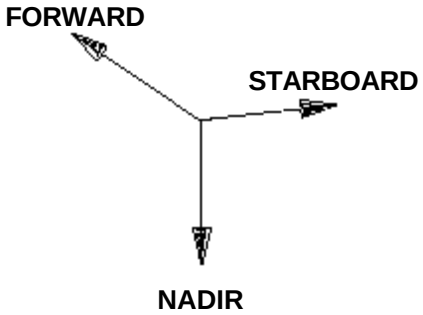
Guidance Navigation and Control
Two Rate Gyro Assemblies Deployed

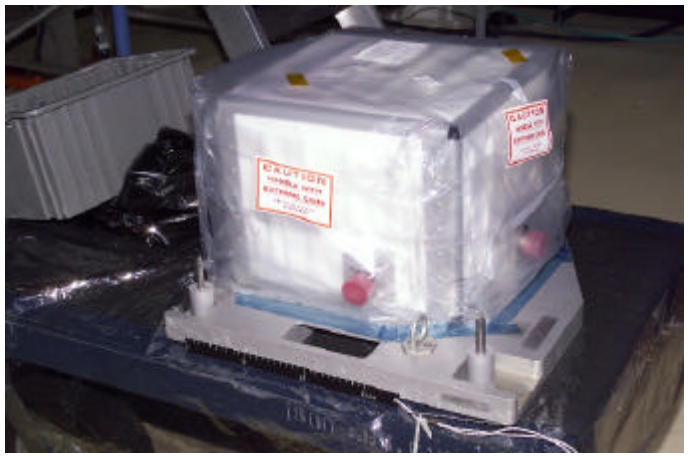
S0 Truss





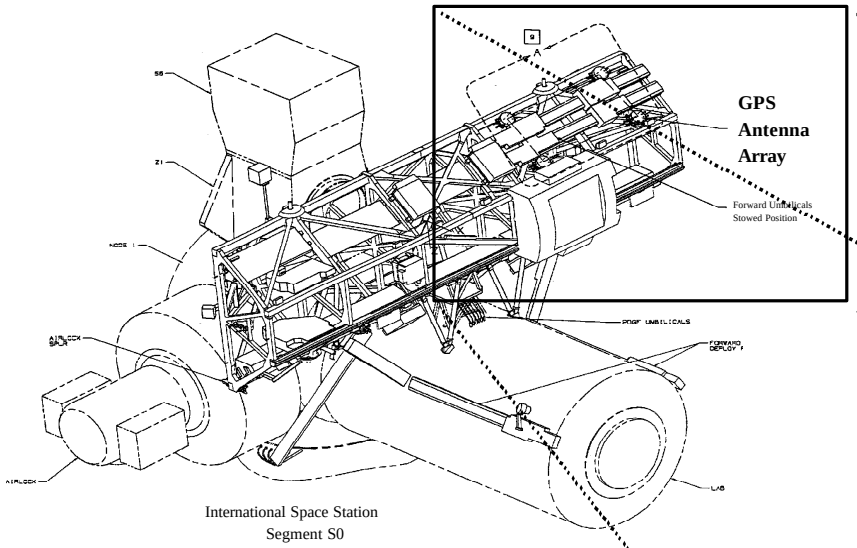




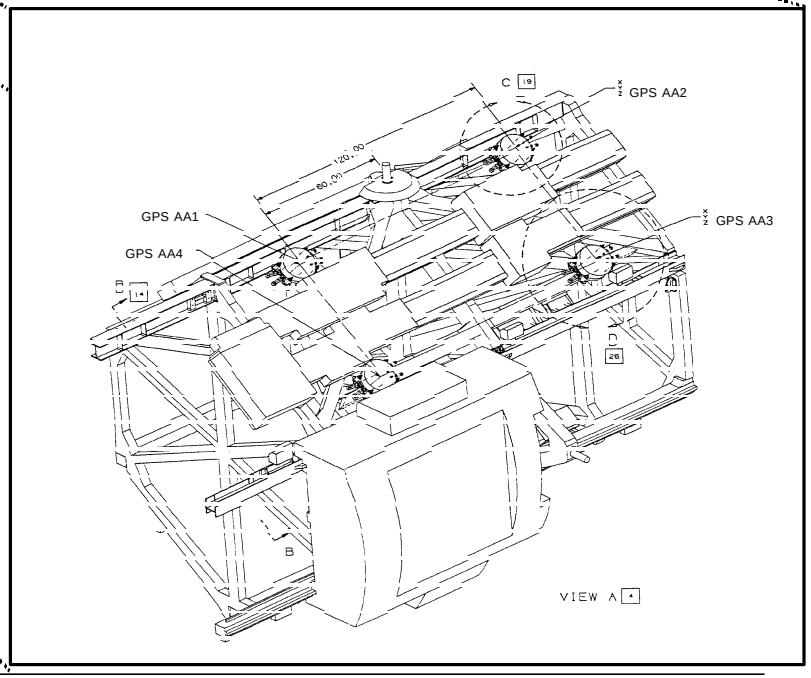


Provides inertial rate data for attitude control

Guidance Navigation and Control
Four GPS Antennas Deployed



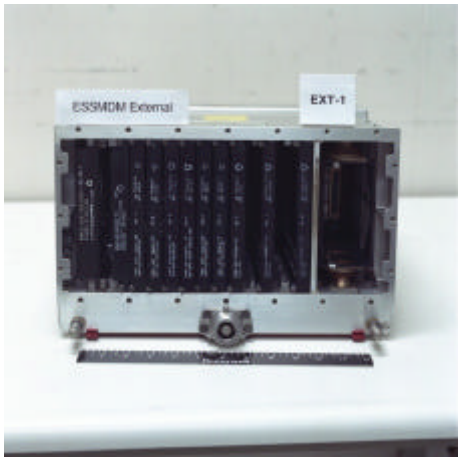
International Space Station
Segment S0



Receives GPS signals for calculating position, velocity, time and attitude

Command and Data Handling

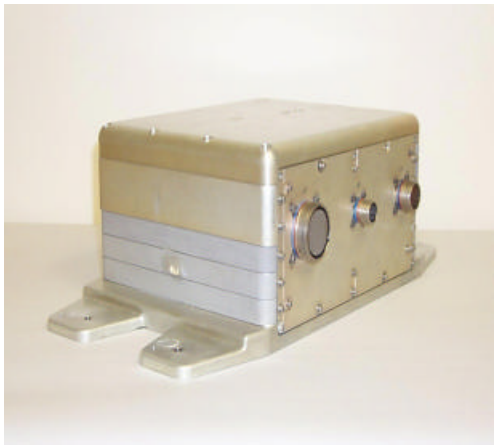
- Three Enhanced Multiplexer Demultiplexers (MDMs)
  - Two located on S0 with External Control Zone Software External (EXT) loaded in memory
  - One spare
- Two Standard MDMs
  - Located on S0 with External Control Zone Software for S0



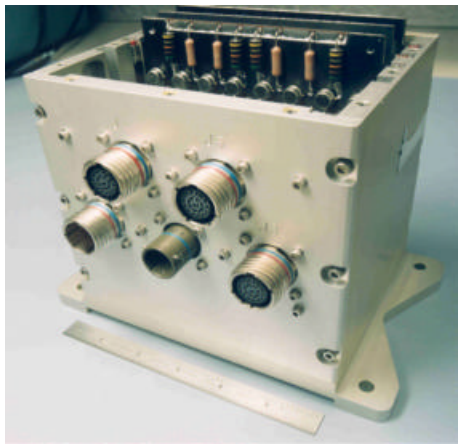
Multiplexer/Demultiplexer

Command and Data Handling

- Two Signal Conditioner Assemblies
  - Amplifies and filters input signals from accelerometers and strain gages
- Four Bolt Bus Controller Assemblies
  - Monitors and controls the bolt motor drive current, direction, and bolt tight limits

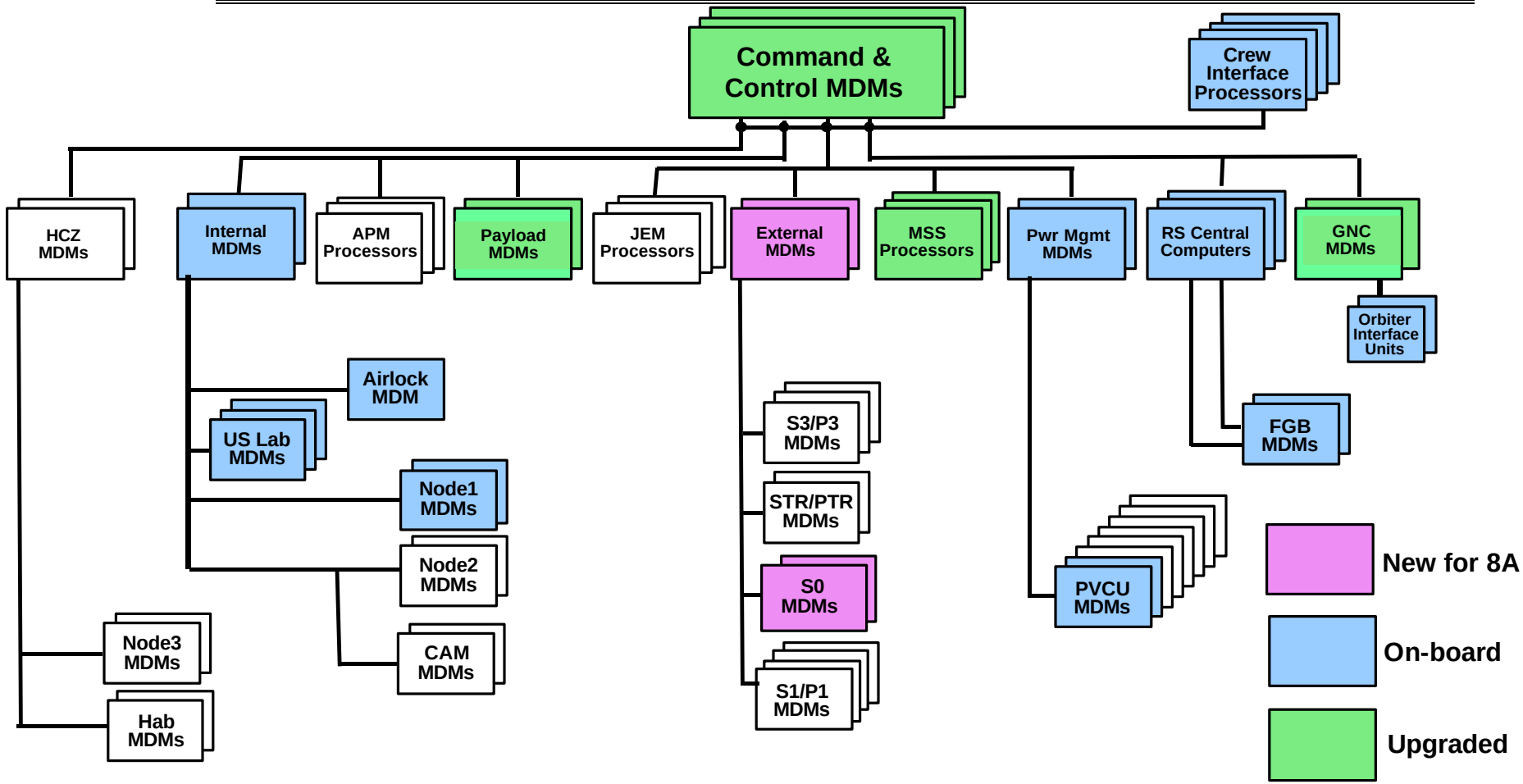


Signal Conditioner Assembly



Bolt Bus Controller Assembly

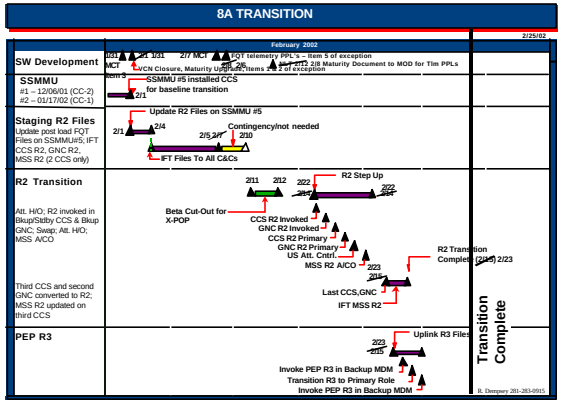
Command and Data Handling Software Architecture



External Control Zone capabilities to support Integrated Truss Segment S0 and Mobile Transporter are new for 8A

Flight Software Deployed Utilizing Three Methods

- **Transition - Utilizing the Solid State Mass Memory**
  - **Command and Control Software**
  - **Guidance Navigation and Control**
  - **Payload Executive Processor**
  - **Mobile Servicing System**
- **Uplink - Utilizing standard uplink procedures**
  - **Mobile Servicing System Recon Files**
  - **Guidance Navigation & Control Flight specific Pre-Position Loads**
  - **Additional patches and Pre-Position Loads**
- **Launch - Utilizing MDM located on the S0 truss**
  - **External Control Zone - External (EXT)**
  - **External Control Zone - S0**



Tremendous coordination effort across all organizations

New Flight Software Functionality

- External Control Zone - EXT
  - Data Systems Management - Manages and controls the data flow
  - Mobile Transporter - Provides status and control needed for the translation of the Mobile Transporter
  - Segment to Segment Attach System - Provides status and control of devices used to connect truss segments
- External Control Zone - S0
  - Structural Dynamics Measurement System Data Acquisition - Collects accelerometer and strain gage measurements for transmittal to ground for structure and loads analysis
  - External Active Thermal Control System - Controls and monitors heat exchanger and bypass isolation valves
  - Passive Thermal Control System - Provides logic to power on and off heaters for the various components based on temperature data readings
  - Secondary Electrical Power System - Monitors status and commands Remote Power Control Module (RPCM) switches

New Flight Software Functionality

- **Command and Control Software**
  - **Provides Command and Control capability for all new USOS hardware and enhanced Redundancy Management**
- **Guidance Navigation and Control**
  - **Provides ISS redundant navigation capability**
- **Payload Executive Processor**
  - **Executes payload operations shutdown, payload operations standby, and rack shutdown notification and Automatic Payload Communication**
- **Mobile Servicing System**
  - **Provides software for the new MSS Mobile Base System for UF2**
- **Portable Computer System**
  - **Displays to support assembly sequence**

Mobile Servicing System

- **The Space Station Remote Manipulator System currently has a failure that prevents the brakes from being released from the prime string**
- **The failure has been isolated within the wrist roll joint**
- **Canadian Space Agency will be delivering a 6DOF software patch**

March 27 - Delivery to Mission Build Facility

March 28 - Delivery to Mission Operations and Hardware/Software Integration for Stage and Operations testing

March 29 - Standalone Software Verification Facility Test

March 30 - Certification letter

March 31 - Mission Control Center step-up

April 1 - Mission Control Center on-orbit test

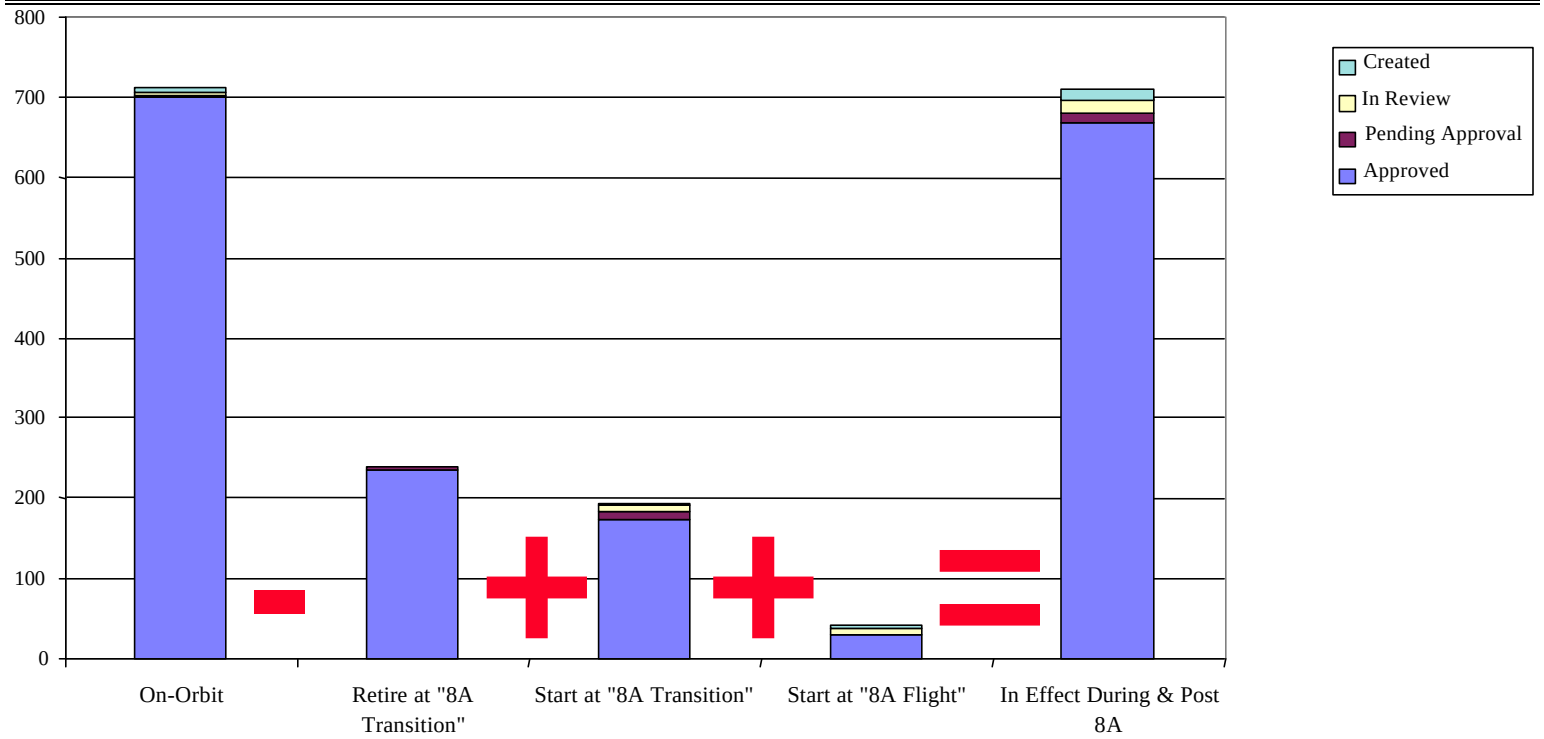
April 4 - Launch

Station Program Notes

- **Station Program Notes (SPN) document procedural work-arounds to preclude known hardware or software error conditions from occurring**
- **The number of SPNs that require crew training outside of documented procedures is low**
- **SPN allocation across ground sub-system teams is fairly evenly spread**
- **The SPN documentation and approval process engages the engineering, safety, operations, and crew office communities**

Station Program Notes pose no threat to flight 8A readiness

Station Program Notes



Flight	Created	In Review	Pending Approval	Approved	Totals
On-Orbit	4	4	4	699	711
Retire at "8A Transition"	0	0	1	237	238
Start at "8A Transition"	3	7	9	175	194
Start at "8A Flight"	4	6	1	31	42
In Effect During & Post 8A	11	17	13	668	709

The number of SPNs remains constant even with this major increase in functionality and the addition of over 4,000 new SLOCs

Avionics and Software Integrated Test Activities

- ✓ **Functional Qualification Testing**
  - **Verification testing conducted at developer sites and vendor locations**
- ✓ **GITF testing**
- ✓ **Hardware Software integration testing**
  - **Hardware and firmware interface checkout conducted in developer labs and in Houston Software Verification Facility (SVF)**
- ✓ **Russian-US 4-Box testing**
  - **One integrated test in Moscow, one formal test in SVF**
- ✓ **Stage Verification testing**

Avionics and Software Integrated Test Activities

- ✓ S0 Truss acceptance testing
- ✓ Multi-Element Integration Testing (MEIT)
- ✓ Post Software Load Integration Testing (PSLIT) at KSC
- ✓ Command and Telemetry Certification
- ✓ Independent Verification and Validation
- ✓ Mission Configuration Test (MCT)
  - S0 Truss Activation Test with Vehicle and MCC-H
  - On-orbit upload procedure check-out

The Avionics Hardware and Flight Software has undergone extensive testing over the last three years

Operations Support and Laboratories Status

- **Support Plan**
  - **Engineering Support Room ready for Flight Following**
  - **Stage Verification Facility configured to follow S0 activation**
- **Mission Evaluation Room (MER) Avionics & Software Support**
  - **Core team is experienced and certified**

Avionics and Software Readiness Summary

- Three years and hundreds of engineers have dedicated themselves to produce quality products to support 8A
  - Developers, integrators, testers, operations and International Partners have worked collaboratively across the program to ensure that ISS needs are met
- Multiple tests and reviews have been conducted identifying problems early in the cycle
  - Unit tests, Truss acceptance, International integration, and Stage Tests all resulting in daily scrutiny of our products

The Avionics and Software community endorses the readiness for 8A

Canadian Space Agency (CSA)

Flight 8A Flight Readiness Review

CSA/William Mackey
(Contributions from CSA/K. Lord & A. Robins and
MD-R/R. Rembala, J. Lymer, J. Scally & L. Oshinowo)

March 26, 2002

Introduction

- On Day 064 GMT (3/5/02), Canadarm2 failed in manner that now prevents the brakes from being released on the Prime string.
- This is a persistent failure, isolated to the Wrist Roll (WR) joint.
- The Redundant string remains fully functional – performance nominal.
- Flight 8A SORR Exception #004 raised against this anomaly.
- CSA/MD-R is generating a software patch that overrides/masks the failed joint and allows Canadarm2 to function without wrist roll using the remaining 6 joints, should it be necessary on Flight 8A.

- This presentation provides an overview of:
  - Canadarm2 Configuration and Functionality
  - WR Joint Failure Signature and Troubleshooting
  - Possible Causes and Corrective Actions
  - Future Work

Canadarm2 Overview

Design life of 15 years

Degrees of Freedom:	7
Joint Control:	7 Joints
Tip Control:	X/Y/Z
	Pitch/Yaw/Roll

Symmetric geometry with offset joints

Can operate from either end as base

Fully redundant control strings (single fault tolerant)

Arm Control Modes: Auto (FOR & Joint)
Manual (SRJM & MAM)

Control Algorithms: 7 Degree-of-Freedom (DOF)
6-DOF with (SR or SY) Held
6-DOF with (SR or SY) Locked

Canadarm2 Overview

Arm Control Unit (x2)
- SACS/AHS, SACS parameters
- Payload control parameters

Joints (x7), Joint Electronics Unit (x14)
- JCS, JCS parameters

Latching End-Effector (x2), LEE Electronics Unit (x4)
- LCS, LCS parameters
- FMS, FMS parameters

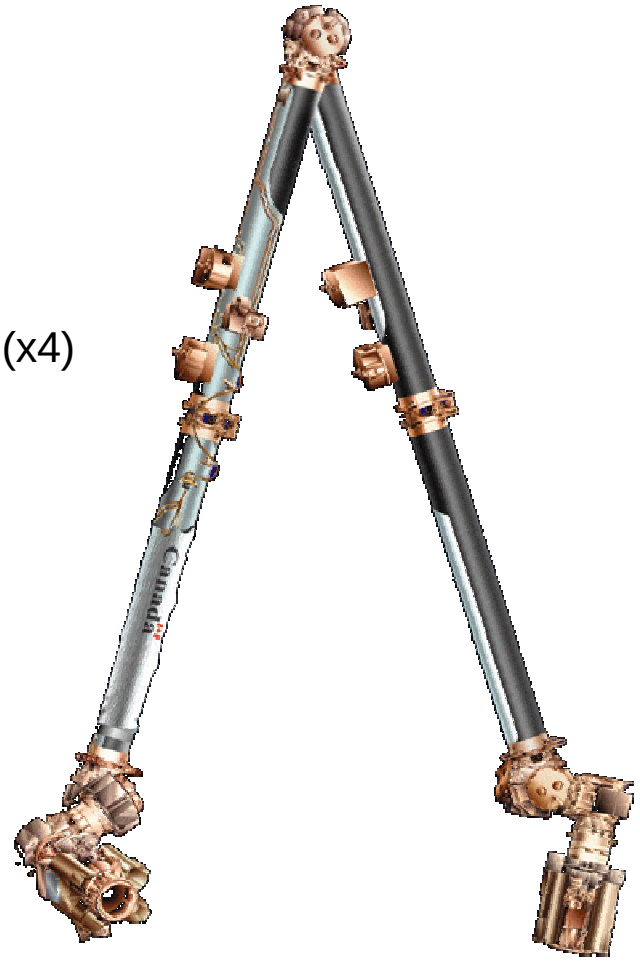
Video Distribution Units (x4)

Camera, Pan and Tilt Unit, Light Assembly (x2)

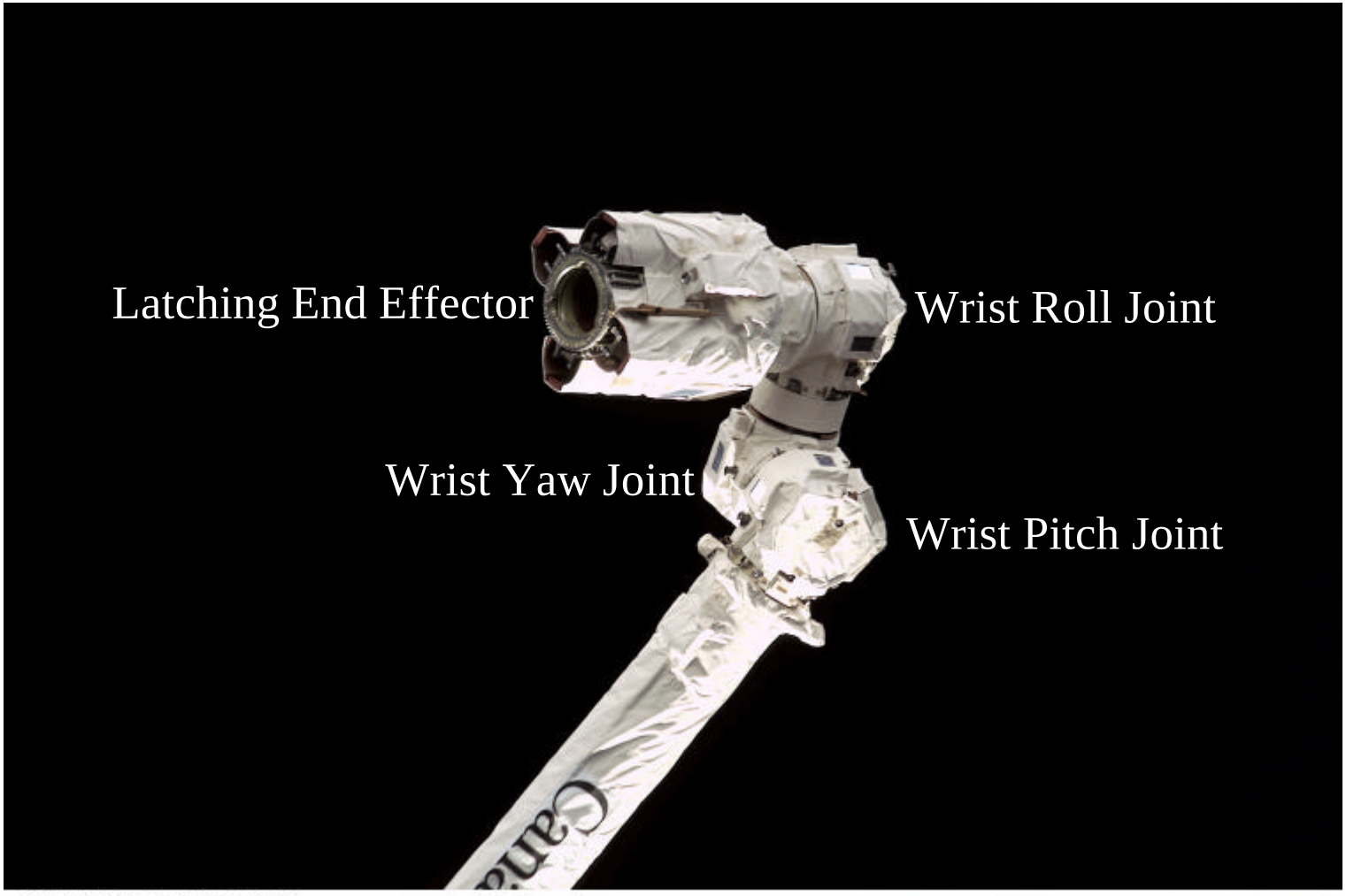
Camera, Light Assembly (x2)

System power (x2)

Payload power (x2)



SSRMS Wrist Cluster



Wrist Roll (WR) Joint

WR Joint Failure Signature

- When the brakes were commanded to be released on Day 064 GMT (3/5/02) with the prime string, SSRMS safed just after **Successful Brake Release** with the following error messages:
    - R3B -- SSRMS ACU DPRT Brake Trip Fail
    - R3B – SSRMS ACU DPRT Brk Switch Fail
    - R3B – SSRMS ACU DPRT Brk Voltage Fail
- All subsequent attempts (Days 64 and 66) to **Release Brakes** resulting in immediate safing and re-annunciation of:
    - R3B – SSRMS ACU DPRT Brk Switch Fail
    - R3B – SSRMS Brk Voltage Err
- When **Joint Brake Diagnostic** tests were commanded on all 7 joints and individual joints resulting in WR joint failure with re-annunciation of:
    - R3B – SSRMS ACU DPRT Brk Voltage Fail
    - R3B – SSRMS Brk Voltage Err
    - All other joint passed brake diagnostics

WR Joint Fault Troubleshooting

On-board Troubleshooting:

- Test Units on WR Joint passed - joint drive electronics are nominal
- Three further attempts to release brakes failed with same signature
- WR Joint Brake Diagnostics Test – WR joint failed with same signature
- Extended Data Dump of high rate joint data captured during brake release attempts for further analysis – results support isolation to WR joint
- High Rate RPCM Data were captured on both strings during brake release attempts for further analysis – input power nominal, quick joint sensor trip

Ground-based Troubleshooting:

- MD-R performed a design scrub and reviewed drawing, schematics, manufacturing and parts MRR/exception/alerts – Fault Tree expanded, no related MRR/exceptions/alerts.
- MD-R & EMS were able to recreate the failure signatures using EMs and QMs in test facilities – possible causes identified.
- **Failure has been isolated to either a short or noise in Wrist Roll Joint.**

Potential WR Joint Failure Causes

- Fault Tree analysis results in six possible areas of suspected fault:
  - Brake voltage detection in the JEU (3.1.4) – Probability Low
  - Flyback diodes on the brake coils (3.2.3) – Probability Low
  - Diode board (3.2.4) – Probability Medium
  - Brake winding & leads (3.2.1 or 3.2.2) – Probability Medium
  - Connector/cable – common to both Prime and Redundant (3.2.5 or 3.4.2) – Probability Low
  - Noise (3.3.2 or 6.0) – Probability Low

Corrective Action

Objective

- Develop a single fault tolerant plan to conduct the 8A mission on schedule.

Chosen option

- Perform S0 install using the capability of 7 DOF Redundant string.
- Generate a software patch to mask WR Joint failure (only) and regain 6 DOF Prime string functionality (should it be required).
  - Two CSCIs (OCS and SACS) modified to accommodate:
    - Single Joint Rate Mode (SRJM) and
    - (Degraded) Manual Augmented Mode (MAM)
- Modify TRICK models in simulators for training crew on 6-DOF patch.
- R&R of the Wrist Roll (WR) Joint on UF2 as decided at SSPCB (03/20) and JPRCB (03/21).

Forward Work

- Close out Flight 8A Exception #004 on SSRMS WR Joint Anomaly
  - Complete the 6-DOF software patch in accordance with the NASA/CSA agreed requirements.
    - 6-DOF patch code delivered to MBF on 03/27
    - FQT certified 6-DOF patch delivered to MBF – NLT 03/30
    - NASA testing and uplink for on-orbit operation per MOD plan.
- Loads analysis on S0 overnight park positions – completed 03/20.
- TRICK models for 6-DOF Prime string training – completed 03/22.
- Complete MTSAS capture loads with 6-DOF patch paperwork – 03/28.
  - MTSAS Loads assessment per NASA EBIT presentation.
- Closeout MER IFI 708 – SSRMS WR Brake Bus Fault (Prime) – 04/02

Readiness Statement

Pending completion of the identified open work, The Canadian Space Agency is prepared to support Flight 8A

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8A and the SSRMS

Castle/DA8

(with data plagiarized from Royce Renfrew, Sarmad Aziz, Dina Barclay, Michelle Hollinger and many others)

Outline

- Goals
- Solutions Found
- EVA impacts
- Training Impacts
- Schedules
- Recommendations

Goals

- Minimize the motion of the WR throughout the entire trajectory of the SSRMS
- Minimize the modification to the nominal trajectory (what the crew has already trained on) in the PLB and RTL.
- Minimize the number of times we would have to drive the WR via EVA.

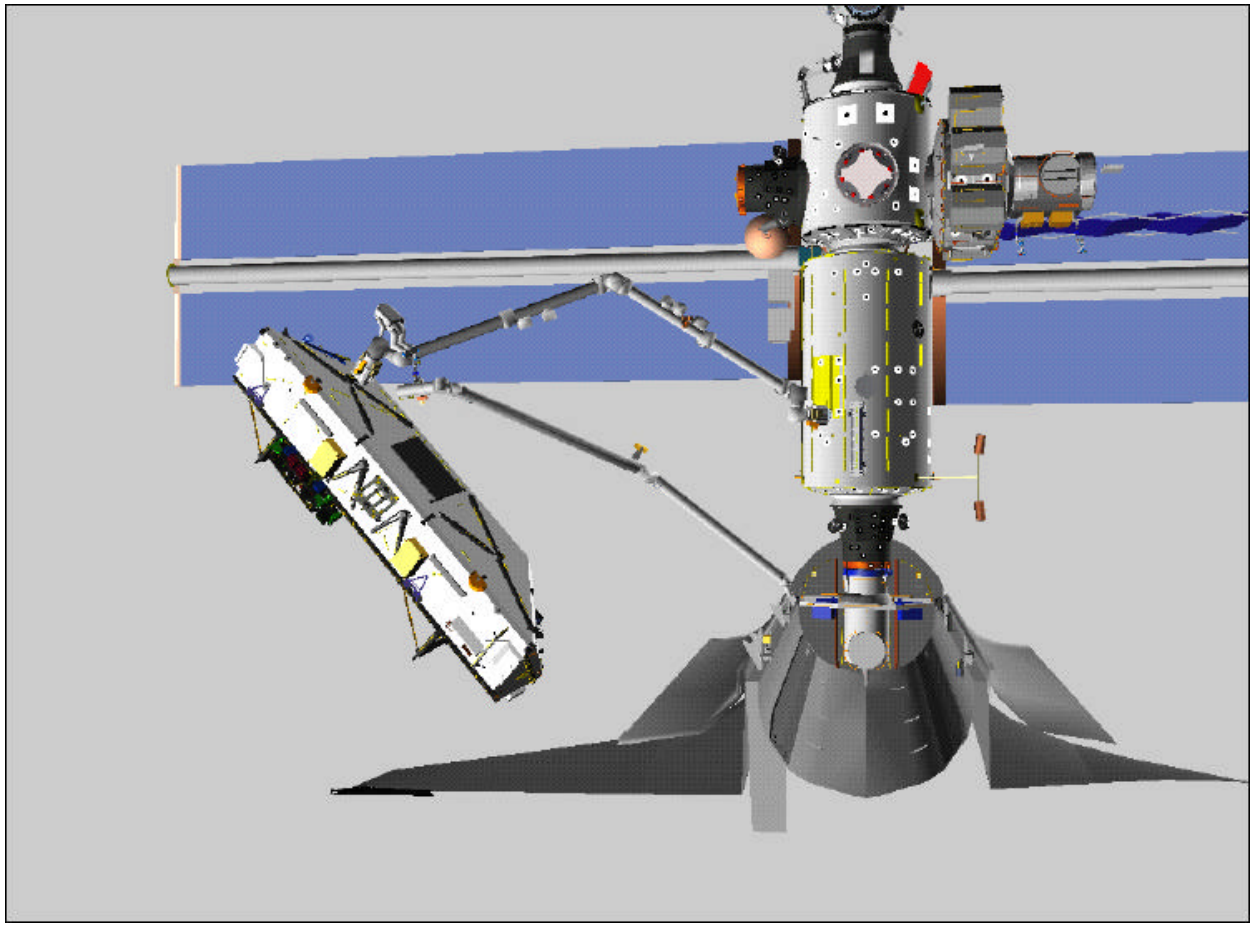
SSRMS Options Found

- 50-210 degree
  - Makes the unberth look very like nominal and the install on the lab look very much like nominal.
  - Only **ONE** WR change required in the failure case. EVA access via SRMS is readily available. With a nominal SSRMS the WR motion is always in the direction the EVA would have to drive it (I.e. it is always getting closer to where we want it).
  - New SSRMS configuration results in somewhat improved camera views for crew.

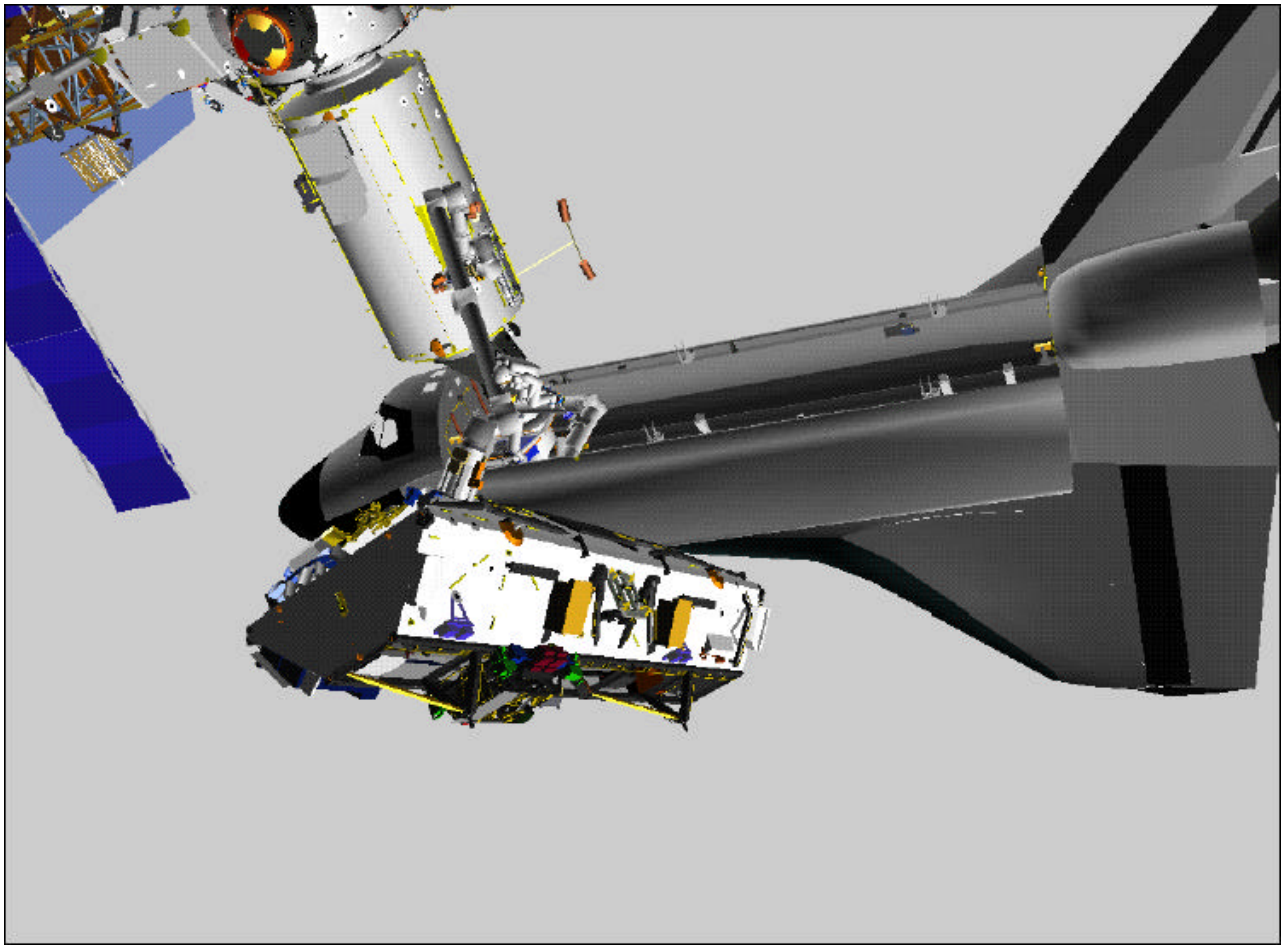
Implications of this new trajectory

- For no further SSRMS failures, this:
  - Makes the entire timeline about 0.5 hour longer than baseline.
    - Adds 1 hours to SSRMS time, but can start earlier so total day impact is 0.5 hours.
  - Provides for a fall back to the 6 DOF SSRMS with minimal impact.
- If SSRMS Redundant string should fail:
  - We can unberth S0, do ONE EVA joint drive, and install S0.
  - We would use the LTA jumper cables to keep all S0 avionics powered and safe on EVA-1.
  - All mandatory tasks can be performed.
  - The “get ahead content” on EVA 4 will likely drop off to the stage or UF-2.

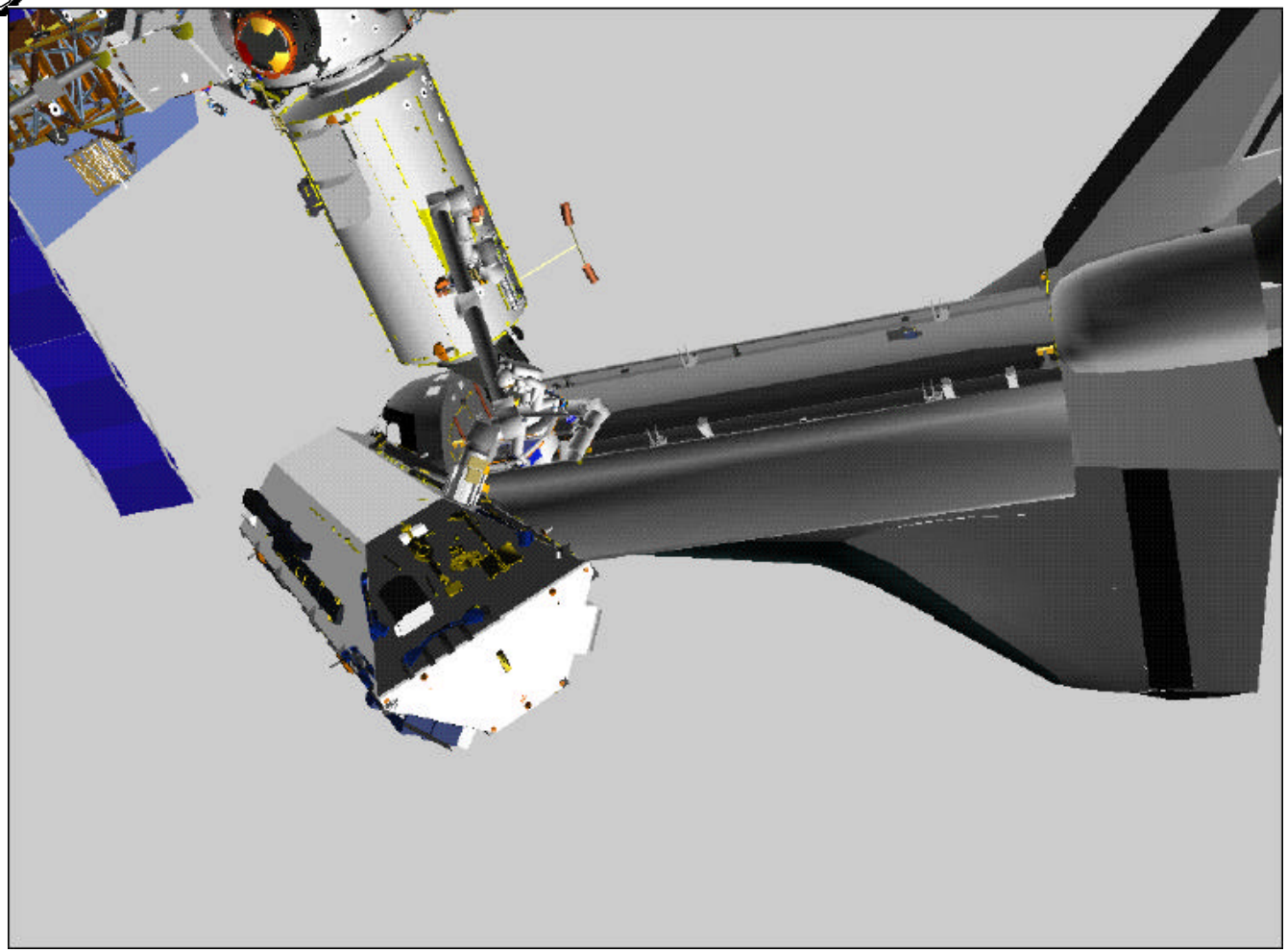
EVA WR Drive Position (WR=-50)



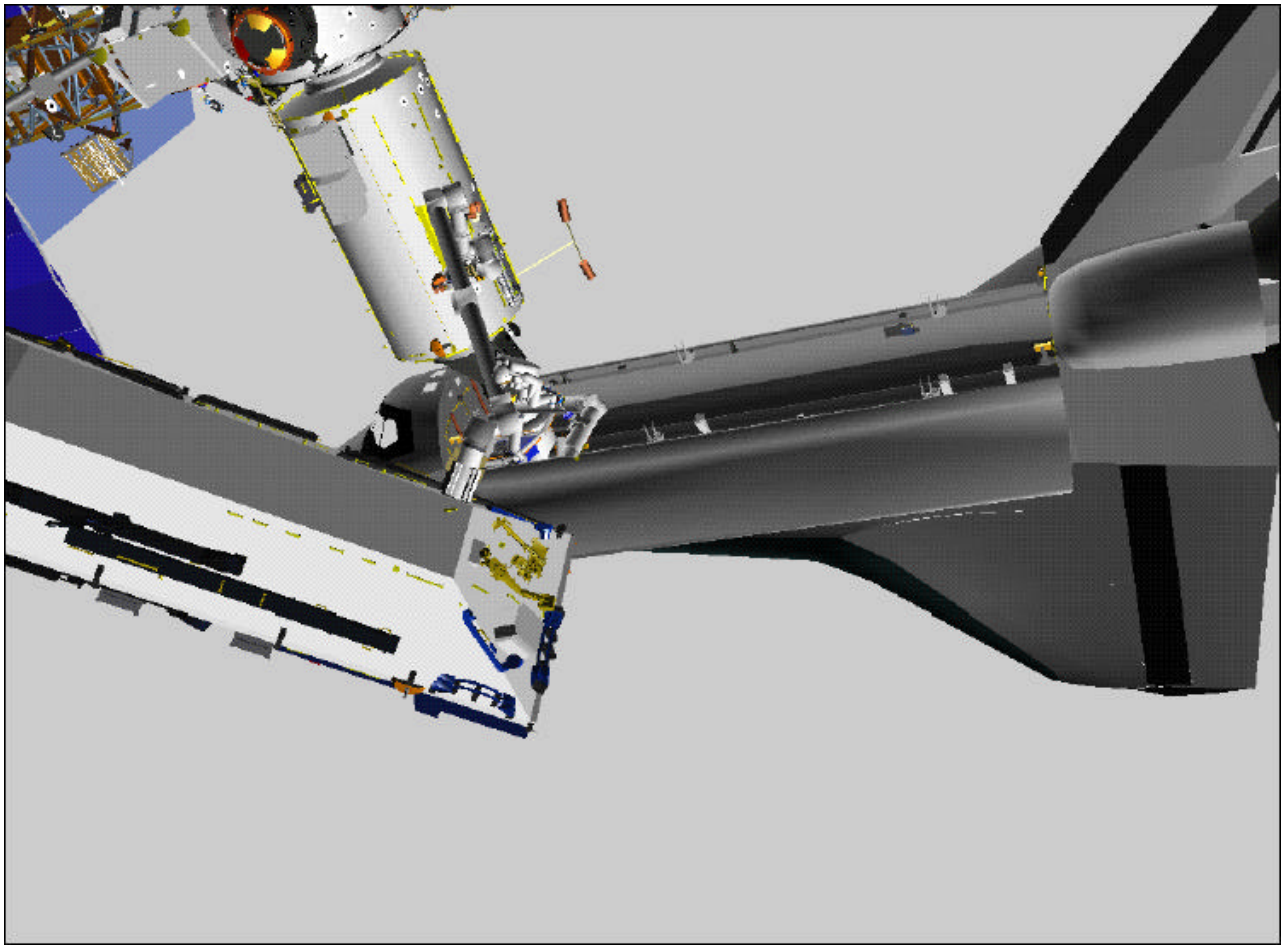
EVA Drive Position WR = -50



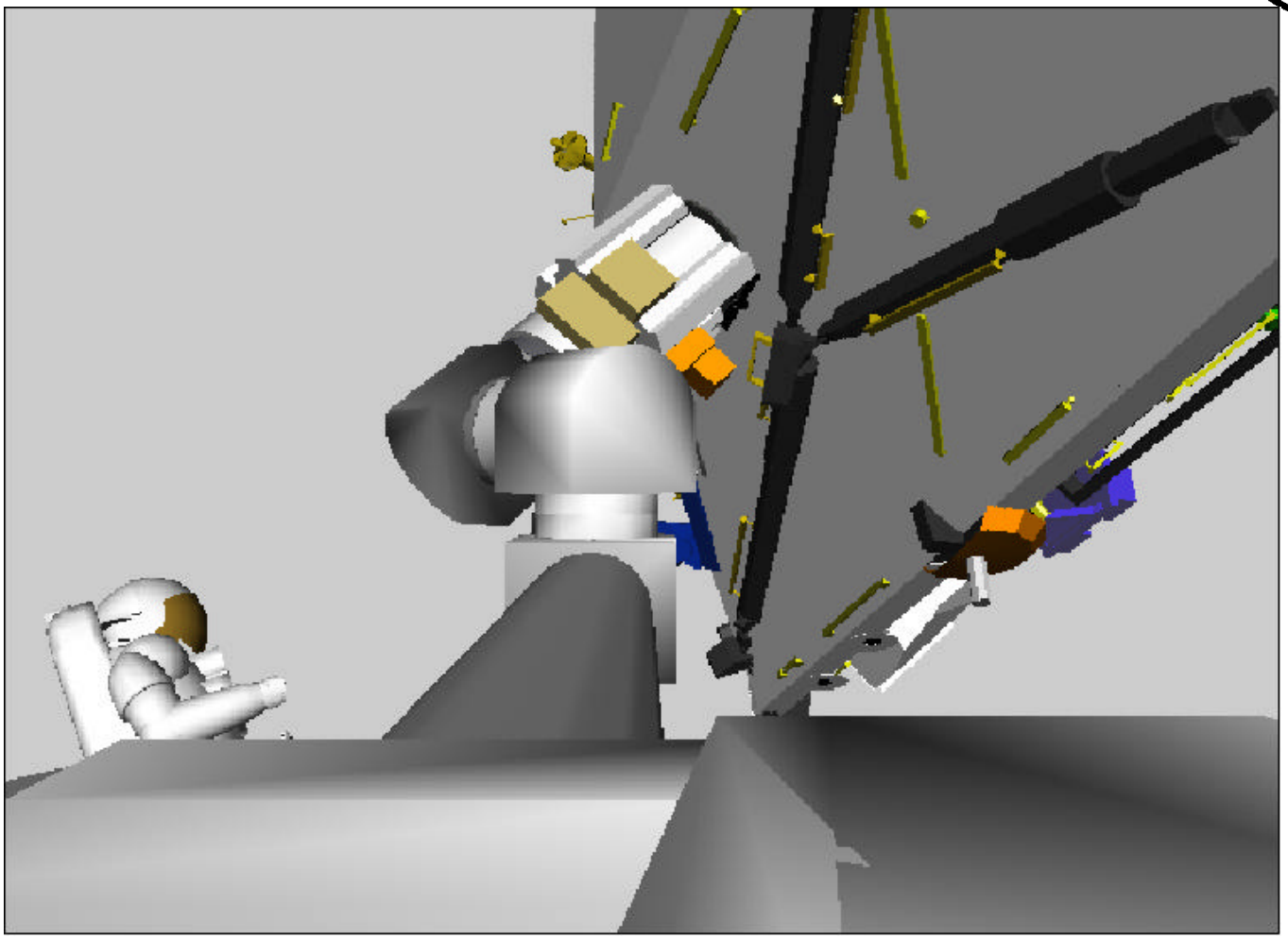
EVA Drive Position WR = -110



EVA Drive Position WR = -210

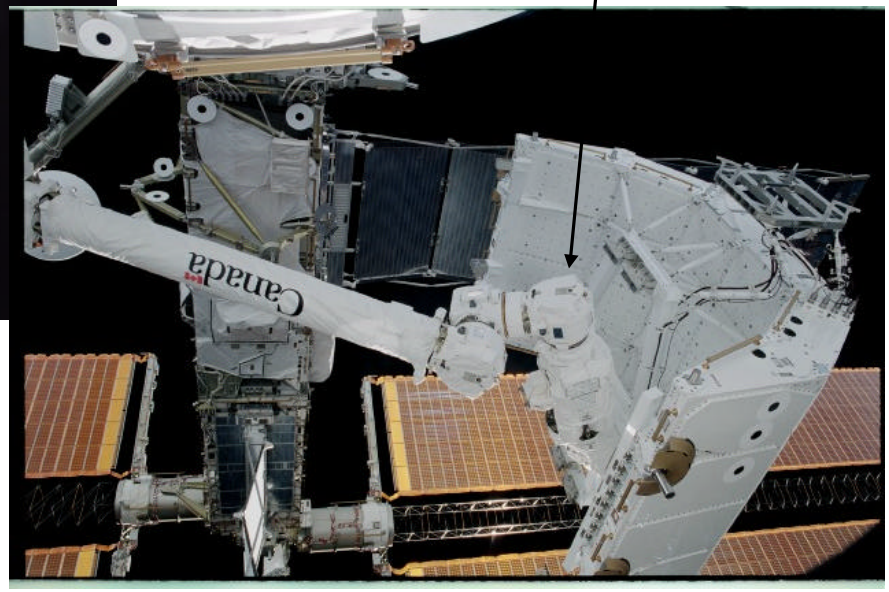


EVA WR Drive Position



SSRMS Manual Joint Drive Photos

Wrist Roll Joint (free end)



EVA Tasks and Impacts if SSRMS Redundant String Fails

- All CAT 1 and CAT 2 tasks can be accomplished with 4 EVAs. All mandatory preps for UF-2 can be accomplished.
- FD 4 is a long and difficult day following a long FD 3. FD 5 really must be an “off” day.
- In the event of SSRMS failure, EVA 1 will consist of:
  - Egress to change WR to –210.
  - LTA jumper installation
  - TUS 2 Nadir installation
  - Port and Starboard Forward struts only if time permits.
- SRMS can help significantly in some cases. Many are already developed and in the PDRS book. The EVA crew is also well trained in many of these tasks either Free Float or on SRMS.
- Following cases will be developed and added to PDRS book.
  - Port Fwd Strut; Fwd Avionics Umbilicals; Port Aft Strut.

Crew Work Day impacts

- New SSRMS trajectory adds about 1 hour to the Robotics Timeline.
- Robotics ops shifted earlier, so total crew work day grew by 0.5 hours to 13.5.
- Failure of SSRMS will not make crew work day longer, it will result in significant changes to EVA 1 and subsequent EVAs.
- Bottom line, the crew workday will not get longer, some content will have to slip to either an extension day or the stage.
- Recommend adding an extension day in event of SSRMS failure such that we had to use the 6 DOF mode.

Training Impacts

- SSRMS (training for S0 install with 6 DOF SSRMS).
  - Crew and DX feel can be accomplished with 1-2 VR sessions
  - VR simulator being modified to 6 DOF was available for a STS crew will have a session on 3/22 and 3/25. This is sufficient and no impact to their training schedule.
  - On Orbit training of both ISS and STS-110 crew is planned.
    - ISS crew during a Robotics day, Plan to dry run on Redundant string on 3/28 and Prime String (with 6 DOF patch) on 4/1.
    - STS crew will train during the FD 3 “payload bay survey” which will use the patch or 6 DOF SW.
  - No training or procedure development planned for EVA support with 6 DOF SSRMS. We will deal with this when it happens and we know we can accomplish minimum objectives without the SSRMS.
- EVA
  - DX and crew are comfortable with plan for 1-2 VR sessions. A quick evaluation of APFR locations for Avionics Umbilicals will be “tacked on” to an existing NBL run on 3/22 or 3/25.

Schedules

3/21	VR Lab simulator modified for 6 DOF use. STS Crew gets a couple of sessions on 6 DOF on 3/22.
3/22	SSRMS Procedures complete (incorporates crew comments from VR sessions and onorbit sessions)
3/26	FRR, Expect some open work.
3/27	ISS Crew has procedure review of new nominal SSRMS.
3/27	If testing has gone well, CSA delivers Code change for 6 DOF patch which allows parallel testing at JSC.
3/28	ISS Crew does run on Redundant SSRMS string.
3/30	CSA delivers patch.
4/1	ISS Crew does run on Prime String with 6 DOF SW patch. WR set to –50 and will remain at this angle until S0 grapple.
4/2	SSRMS Pre-launch checkout. Redundant String.
4/6 - FD 3	STS Crew session with SSRMS in both 7 DOF and 6 DOF modes.
4/7 – FD 4	S0 Grapple.

Open Work

- Load 6 DOF patch onboard ISS and complete on-orbit crew training and SSRMS Checkout with 6 DOF patch.
- Update Flight rule for 6 DOF patch and SSRMS grapple GO/NOGO.
- Finalize Flight rule updates at JPRCB on the 28th.

Recommendations

- Proceed to 8A launch with the 50-210 option with EVA workaround if required.
  - If the next failure occurs we will lose part of the 8A mission but can accomplish all CAT 1 and 2 objectives and all mandatory precursor activities for UF-2.

8A Flight Readiness Review
Berthing Loads Summary

End-to-End Berthing Integration Team

Brian Richard / Lou Ramon

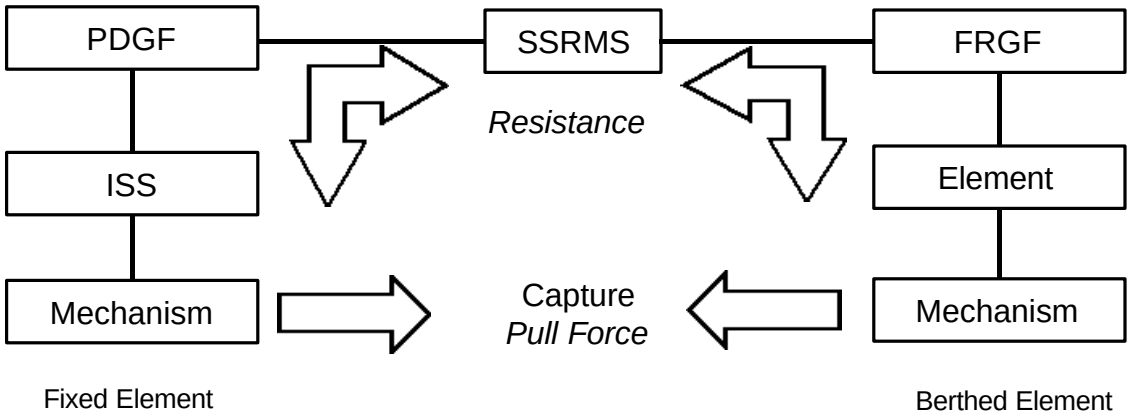
March 26, 2002

8A Berthing Loads Issue Description

- Nominal berthing operation
  - 1st Stage Capture
    - Mechanism from Ready-To-Latch (RTL) to Topological Capture (TC)
    - SSRMS in “Position Hold”
  - 2nd Stage Capture
    - Mechanism from Topological Capture (TC) to Full Seat (FS)
    - SSRMS in “Limp”
- Mechanism capture operations may cause loads that exceed SSRMS and element grapple fixture hardware capability for both
  - Nominal
  - Off-nominal
    - Many anomalies cause “safing” (brakes applied to joints)
- Analysis and resolution has been led by End-to-End Berthing Integration Team (EBIT) with significant contributions and participation from EBIT members
  - CSA, Boeing, NASA-JSC (ISS, Engineering, MOD, Crew Office), and Safety

8A Berthing Loads Background

- Loads develop when active berthing mechanism engages passive mechanism
- System must comply when pulled from ready-to-latch to full seat
- Motion induced by this constrained operation is magnified by the mechanism-to-GF offset and element positioning dispersions, resulting in large forces and moments at the interfaces - especially at FRGF/LEE, and especially when brakes are applied



8A Berthing Loads Summary

- This summary addresses SSRMS operations on either string
  - 7 healthy joints (Redundant string)
  - 6 healthy joints and the Wrist Roll locked (Prime string)

Mechanism Capture Stage	SSRMS Nominal	SSRMS Off-Nominal
First (RTL to TC)	SSRMS in Position Hold **GOOD**	SSRMS Brakes-on **GOOD**
Second (TC to Full Seat)	SSRMS Limp **GOOD**	SSRMS Brakes-on **GOOD***

* Crew Intervention control for Second Stage Off-Nominal
  - Provides a minimum of 30 seconds for Crew intervention to control hazard
  - Margin provided by using rise times for loads to achieve 84% of Flight Planning Load Limits

8A Berthing Loads Conclusion

- Berthing loads analysis successfully completed
  - Addresses both 7-joint and 6-joint SSRMS operations
- Operational procedures completed
- Safety review and concurrence
  - NCR approved to use Crew to control the potential hazard

EBIT recommends proceeding to 8A Launch

Summary

- Flight objectives and priorities are defined.
- Flight manifest has been defined.
- Hardware delivery and processing schedule supports launch date.
- All hardware and software certifications are complete or will be complete prior to launch.
- Personnel and facilities are ready to support.
- Special topics have been resolved or have acceptable operational workarounds except the following exception:
  - Canadarm 2 Wrist Roll Fault--- Closure pending:
    - Completion of software certification
    - 6 DOF software patch upload
    - On-orbit Checkout of 6 DOF software patch
  - This exception is expected to be cleared by L-2.

The ISS Program is ready to proceed with the Launch of ISS 8A/STS-110